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NUCLEAR SCIENCE ABSTRACTS

Vol. 3 No. 7

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BIOLOGY AND MEDICINE

1318 Initial studies of the effect of laboratory produced air blast on animals. Benedict Cassen, Lawrence Curtis, and Katherine Kistler. AECU-396, July 1, 1949. 18p.

Simple equipment was developed for subjecting mice to a controlled air-pressure pulse produced by bursting a diaphragm separating the test chamber from a pressure compartment. In routine use it is easy to test 20 mice per hour, including autopsy for gross damage and recording the degree of lung hemorrhage produced by the blast. Preliminary observations have been made on approximately 4000 mice. The degree of lung hemorrhage was studied for its dependence on the blast pressure, the volume of the compression compartment (affecting the duration of the pressure pulse), the spatial orientation of the animal, the previously induced damage from irradiation by 250 kv x-rays, and the premedication with some vitamin P-like compounds.

1319 Mutants of bacillus subtilis that require threonine or threonine plus methionine. Howard J. Teas. AECU-405, Aug. 15, 1949. 32p.

A study of the nutrition of twelve *Bacillus subtilis* mutants that required specific amino acids is reported. Seven required threonine; two required both threonine and methionine, but could utilize homoserine instead; and three required threonine and methionine, but were unable to grow on homoserine alone. Indications are that in *Bacillus subtilis*, as in *Neurospora*, homoserine is a precursor of both threonine and methionine. One of the threonine-methionineless mutants was reverted to wild type with a frequency of about 3×10^{-7} using 90,000 - 100,000 r of x-rays.

1320 The experimental study of flash burns. J. Thomas Payne, Lewis Hogg, and H. E. Pearse. AECU-407, June 3, 1949. 31p.

The importance of the flash burn as a clinical entity was pointed out by the Navy at Pearl Harbor, and by observers of the Hiroshima and Nagasaki casualties. It was estimated that in these latter cities, from 60 to 80% of the casualties sustained flash burns, and 90% of all persons seeking medical aid in the first few days, were so burned. The treatment of such large numbers of burns presents great problems, if done according to present standards. An attempt was made, therefore, to produce a flash burn in the laboratory, and study the morphology and factors altering its morphology. A rather detailed search for appropriate flash sources was made, with the selection of Mg flash powder as a likely agent. A series of about ninety burns were produced on the pig, using burning Mg as the high intensity, brief duration flash source. These lesions typically presented a zone of central pallor surrounded by abrupt erythema. The erythema and edema resolved over four to seven days, leaving only a thin central crust, which came free at about ten days. Histologically the lesions presented an abrupt, linear demarkation at their margins, as well as their depths, as shown by hair follicle and dermal changes. Healing was by sequestration of the burned tissue, rather than by organization, and required from three to five days as a minimum, with larger lesions not healed by two weeks. This is a unique picture, and is intimately related to the transfer of heat through the cutaneous layers. The development of flash burns by other sources and burning techniques is in progress. Measurements of the sources as well as heat transfer through the tissues are in progress as well.

1321 A preliminary investigation of blood fluoride levels following exposure to hydrogen fluoride at a concentration of approximately 29 mg/m^3. F. A. Smith and D. E. Gardner. AECU-406, May 25, 1949. 21p.

Exposure of rabbits to approximately 29 mg HF/m^3 for intervals of one to five days results in a five-fold increase in the blood fluoride level. The fluoride level reaches a plateau after one day of exposure and does not increase with continued exposure. The fluoride content decreases immediately following termination of the exposure, but is still significantly above normal for at least three days after the animals are removed from the HF atmosphere.

1322 The effect of nitrogen mustards on the metabolism of nucleic acids in the hematopoietic tissue of the rabbit. P. B. Lowrance and C. E. Carter. AECU-395, nd. 23p.

The effect of intravenously administered nitrogen mustard on the content and P^{32} uptake of the nucleic acids of rabbit bone marrow, spleen, and thymus has been studied. The content of both ribonucleic acid (RNA) and desoxyribonucleic acid (DNA) in all tissues studied was diminished at 12-24 hours following injection of the nitrogen mustard. It returned approximately to control levels in bone marrow and spleen by the fourth day after injection of nitrogen mustard, but in the thymus remained depressed throughout this period. The incorporation of P^{32} into DNA was markedly depressed 12-24 hours after the nitrogen mustard was given, then increased to

BIOLOGY AND MEDICINE (continued)

values greater than the controls. The specific activity of the RNA fraction was not depressed below control levels. These effects were considered to be consistent with either abnormal mitotic activity or with regeneration of tissue. In vitro experiments, in which bone marrow was incubated in the presence of 5×10^{-4} M nitrogen mustard, exhibited a depression of incorporation of inorganic P^{32} into the DNA fraction prior to inhibition of respiration.

1323 The path of carbon in photosynthesis. VII. Respiration and photosynthesis. A. A. Benson and M. Calvin. AECU-413, July 21, 1949. 16p.

The relationship of respiration to photosynthesis in barley seedling leaves and the algae, Chlorella and Scenedesmus, has been investigated using radioactive C dioxide and the techniques of paper chromatography and radioautography. The plants are allowed to photosynthesize normally for 30 sec in $C^{14}O_2$ after which they are allowed to respire in air or He in the light or dark. Respiration of photosynthetic intermediates as evidenced by the appearance of labeled glutamic, isocitric, fumaric, and succinic acids is slower in the light than in the dark. Labeled glycolic acid is observed in barley and algae. It disappears rapidly in the dark and is maintained and increased in quantity in the light in CO_2-free air. Radiograms of algae and barley extracts in which the C^{14} was reduced in the dark by preilluminated plants show the same compounds as produced in normal photosynthesis. This includes a considerable amount of sucrose.

1324 Distribution of C^{14} in glycine and serine of liver protein following the administration of labeled glycine. Patrick D. Goldsworthy, Theodore Winnick, and David M. Greenberg. *J. Biol. Chem. 180*, 341-3(1949) Aug.

1 mg of $NH_2C^{14}H_2COOH$ (4.57μc or 560,000 counts/min/mg) was injected intraperitoneally into a 200 g male rat, and 1.3 mg of $NH_2CH_2C^{14}OOH$ (7.2μc or 880,000 counts/min/mg) into a second rat; the first animal was killed after two hours and the second after 21 hours. Approximately 1.5 g of protein powder were then prepared from each liver by the method given in a previous paper, T. Winnick, et. al., *J. Biol. Chem. 175*, 127(1948), and 100 mg portions of the proteins were mixed with 400 mg of glycine or L-cystine. In the experiments with serine carrier (in which two derivatives were prepared), 200 mg of protein and 800 mg of DL-serine were employed. The mixtures were hydrolyzed, and the amino acid carriers reisolated, recrystallized repeatedly from hot water, and converted into the suitable derivatives described. High concentrations of C^{14} were found in the serine, as well as in the glycine, of liver protein; the serine accounted for 35 - 43%, and the glycine 45%, of the total C^{14} in the liver protein.

1325 Iron metabolish. Utilization of intravenous radioactive iron. Clement A. Finch, John G. Gibson, Wendell C. Peacock, and Rex G. Fluharty. *Blood 4*, 905-27(1949) Aug.

Studies to determine the dynamic relationship between storage and circulating iron in normal subjects and in patients with a variety of hematologic disorders through the use of radiation iron (Fe^{55} and Fe^{56}) are reported. When single tracer doses of radio-iron were given intravenously to human subjects, it was observed that the radio-iron rapidly entered the hemoglobin cycle and tagged erythrocytes began to appear in the circulation within 24 hours: the radioactivity of the circulating red cells continued to rise up to two weeks after the injections. Radio-iron Fe^{55} was usually given and in sufficient concentration to produce 1,000,000 counts/min in each case; patients with Fe deficiency, hemochromatosis, refractory anemia, uremia, infections, hemolytic anemia, pernicious anemia, malaria, malignancies, hepatis disease, endocrinological disease or polycythemia were the subjects chosen and the results were compared against those obtained from normal subjects. The internal Fe metabolism was measured by determining the percentage utilization of the intravenously administered radio-iron for hemoglobin production over a period of two to three weeks. It was found that in Fe depletion cases more complete and rapid utilization of the radio-iron occurred; states of Fe excess, such as hemochromatosis displayed profound depression of radio-iron utilization. The rate of erythropoiesis was estimated by the slope of the utilization curve, and evidence of abnormal red cell destruction was found in cases showing an early and abrupt plateau of the utilization curve. A correlation is made between the radio-iron utilization and the clinical factors of the hematologic disorders studied. 24 references.

BIOLOGY AND MEDICINE (continued)

1326 Summary of mouse genetics work. Donald R. Charles. AECU-378, nd. 2p.

The objectives of the work of this laboratory have been: (1) to determine how often dominant mutations occur in the sperm of mice exposed daily to x-radiation as a function of the daily dosage and number of exposures; (2) to find a way of judging whether certain of these mutations (semi-sterilities) would, if they occurred in humans, have serious consequences for individuals inheriting them; (3) to investigate the extent and duration of chromosome damage, produced by single x-ray doses ranging from 58 to 229 r, in certain "poietic" tissues whose main activity is constant and rapid production of new cells, as a possible cause of the reduction, after x-ray exposure, in the cell populations normally replenished by the poietic tissues.

Results have been obtained as follows: (1) At least twenty mutations are found to have occurred in the sperm of exposed and control males. Of the twenty mutations, nine are semi-sterilities, three are sex-linked lethals, and eight are dominant gene mutations. (2) Uterine deaths of offspring from semi-sterile humans should occur before the end of the seventh week, and thus should not be a serious medical problem. (3) Broken chromosomes are increasingly frequent in cells dividing within the first hour after exposure. Two days after exposure few or no broken chromosomes are to be found.

1327 The value of blood counts in individuals exposed to ionizing radiation. Norman P. Knowlton, Jr. AECU-397, nd. 25p.

A study of the blood counts of 10 men exposed to about 0.2 r of γ rays per week for 117 weeks showed a small but significant decrease in the white blood cell, absolute neutrophil, and absolute lymphocyte counts. A control group of 117 individuals showed no such change while a group of 46 people exposed to 0.01 to 0.1 r per week showed a slight but not very significant decrease in these blood elements. It was concluded that, although the routine blood count is a poor detector of radiation injury, it is the best clinical test available.

1328 Tabulation of available data relative to radiation biology. Andrew H. Dowdy. NEPA Division Report NEPA-1019, 1949. 45p.

This document has also been assigned the number AECU-353. An abstract of AECU-353 was listed as NSA 3-1036.

1329 Safety criteria in radioactive water monitoring. H. A. C. McKay and G. N. Walton. *Nucleonics 5*, 12-21(1949) Aug.

The basic principles involved in testing water for radioactive contamination are considered. The problem is to develop monitoring procedures which are valid despite the limitation of a minimum of information on the identity and proportions of the radioactive isotopes likely to be present. Calculations are made of the safe values of the maximum permissible counting rates from radioactivity-contaminated water samples. Criteria are obtained which are valid for unknown mixtures of contaminating isotopes, based on an additivity rule for the hazards from the separate isotopes. Consideration is given to the use of information limiting the amount of the most dangerous isotope(s) present, and to the modification of the monitoring procedure by means of absorbers or by radioactive decay. The various criteria developed are illustrated by numerical examples based on an arbitrarily calculated set of permissible doses.

1330 Studies of the hazard involved in use of carbon 14. I. Retention of carbon from labeled sodium bicarbonate. Howard E. Skipper, Locke White, Jr., and Carl E. Bryan. Southern Research Institute, Mar. 28, 1949. 21p. (NP-961).

Studies on the rate of expiration of $C^{14}O_2$ following injection of $NaHC^{14}O_3$ indicated that the half-life of bicarbonate carbon in mice is less than 10 min. Greater than 90% of the total activity injected was lost through the respiratory route in 1 hr. Twenty-four hours after injection of $NaHC^{14}O_3$ about 90% of the blood radioactivity was found to be fixed in a non-carbonate form. The remaining 10% was removable by acid-vacuum treatment. No profound localization of C^{14} from $NaHC^{14}O_3$ has been observed with regards to organs and tissues. However, uptake and turnover was more rapid in the jejunum, a tissue having a high mitotic activity, than other tissues studied. The specific activity of whole long bones paralleled that of the blood. When $NaHC^{14}O_3$ was injected into a pregnant mouse, the rapidly growing embryo tissues were found to fix C^{14} more rapidly than the parent mouse tissues. Data have been presented showing the retention of C^{14} from $NaHC^{14}O_3$ in tissues, bone, and the total body of mice at 24 hr, 48 hr, 1 week, 2 weeks, 4 weeks, and 12 weeks. The body radiation of mice injected with 18 μc of

BIOLOGY AND MEDICINE (continued)

$NaHC^{14}O_3$ has been calculated to be 0.11 rep per day for the first 24 hr. The average daily rep dropped to about 0.003 for the period of 1 - 3 months. These calculations were based on the assumption of equal distribution.

1331 Adenocarcinoma of the uterus. Observations on treatment and histologic findings following intracavitary radiation. J. Mason Hundley, Jr., Everett S. Diggs, and Theodore Kardash. *Am. J. Obstet. Gynecol.* 57, 52-68(1949) Jan.

The results of treatment of adenocarcinoma of the uterus with intracavitary Ra and deep roentgen therapy are presented and the tissue reactions are discussed. The patients were divided into the poor risk group and the good risk group; both groups received the intracavitary Ra therapy as the main treatment, while roentgen therapy was supplementary. The good risk patients were given a variable number of 10 mg Ra applicators, which were inserted into the uterus long enough to deliver a total dosage of 4,000-4,500 mg-hr; Ra tandem treatments were also given. A panhysterectomy and a bilateral salpingo-oophorectomy also were usually performed following the radiation treatment; they were followed by a course in deep roentgen therapy consisting of a total of about 8,500 r. The procedure for the poor risk group was the same as for the healthier group, except that surgery was not performed. Combinations of these methods were used in individual cases as was indicated by the condition of the patient. Tissue response was extremely variable; tissue selectivity was demonstrable. The 5-year survival rate of 32 patients treated by the intracavitary Ra and panhysterectomy method was 84.4%, while the survival rate of 34 patients treated by intracavitary radiation and a cycle of deep roentgen therapy was only 20.6%. There were no operative mortalities or untoward sequelae during convalescence for these cases.

CHEMISTRY

1332 Zirconium hydride. A. L. Grunewald. NEPA Division Report NEPA-502. Apr. 20, 1948. 42p.

The hydrogen compounds of Zr have been of interest in connection with the investigation of shielding materials. Available information is presented in this report under the following headings: property data, fabrication data, preparation, analysis, equilibrium studies with other elements and compounds, nuclear data. 18 references.

1333 Analytical chemistry of the Manhattan Project. Other methods. F. E. McKenna, L. L. Quill, J. Schubert, and J. C. Warf. AECD-2676, nd. Decl. Aug. 17, 1949. 87p. For publication in NNES, Div. VIII, Vol. 1, Chap. 29.

Part 1. Chromatographic adsorption methods of quantitative separation. The following topics are discussed: principles governing ion exchange adsorption under both equilibrium and non-equilibrium conditions; experimental procedures and techniques including types of adsorbents, description of apparatus, preparation of adsorption columns, and detailed analytical procedures for separation and concentration of cations. 24 references.

Part 2. Gas analysis. Descriptions of conventional absorption apparatus and analyses are given. A micro-Orsat apparatus including the reject, input, absorption, and compensator arms is described in detail.

Gas analysis by thermal conductivity measurements are also discussed. The General Electric, Princeton, and Engelhard Double By-Pass thermal types of conductrimetric units are described. Procedures for analysis of mixtures containing corrosive gases such as HF are detailed. The general characteristics of thermal conductimetric apparatus such as pressure dependence of cells, effects of gas flow rates and temperatures, and flushing times are outlined.

The principles, apparatus, and procedures for analyzing gas mixtures through measurement of refractive indexes by interferometric methods is given.

The determination of the moisture content of gases by dew point methods, by thermometric measurement of the heat of reaction with dehydrating agents, and with cobaltous cyanide paper are reviewed.

Miscellaneous gas analyses such as the determination of O content by magnetic susceptibility measurements, and the determination of Hg and trichloroethylene vapors in the atmosphere are included. 38 references.

Part 3. Mass spectroscopy. Brief mention is made of the use of the mass spectrometer for isotopic analyses of water, U, and stable isotopes, and for the qualitative and quantitative analyses of gas mixtures, fluorocarbons, Pu and U. 9 references.

CHEMISTRY (continued)

Part 4. Pyrohydrolysis. In this method the hydrolyzable substance is heated while exposed to a current of superheated steam. The steam carries out the volatile acid component which is condensed and titrated with standard base; the remaining oxide is dried and weighed. Procedures for the analysis of light metal halides and for the tri- and tetrachlorides and bromides of U and Pu are given.

Part 5. X-ray analysis. Three types of analyses using x-rays are discussed: (1) diffraction of x-rays by crystals and interpretation of the resulting crystal structure diagram, (2) the production of characteristic x-radiation of the sample and analysis of the resultant spectrum, (3) the absorption of x-rays, particularly for the determination of U. 22 references.

1334 Application of the chromatographic technique to the qualitative analysis of nickel traces. F. Burriel-Marti and F. Pino Perez. *Analyt. Chim. Acta 3*, 468-75(1949) July.

Some experimental results on the heterogenous reaction: metal ion-solid dimethylglyoxime, which have been obtained by the chromatographic technique are reported. The fact that a reaction occurs in a dynamic system instead of the usual static systems, permits the detection of small quantities of ions in the presence of others which interfere, and in relative concentrations of the latter which are much higher than is ordinarily the case. As the amount of reagent which enters in the reaction is limited by its solubility in the liquid which passes it and can be modified by changing its flow, the compounds with a smaller product of solubility will precipitate alone and be retained by the columns.

1335 Quantitative inorganic paper chromatography: sub-micro separation and determination of aluminium, iron, and titanium. A. Lacourt, G. Sommereyns, E. Degeyndt, J. Baruh, and J. Gillard. *Nature 163*, 999-1000(1949) June 25 (Letter to the editor).

The sub-microscopic separation and determination of Fe, Al, and Ti using downward development paper chromatography are described. The various types of solutions which have been investigated for their relative merits in the production of these chromatograms are discussed and the procedure with formic acid is considered in some detail.

1336 Ion exchange equilibria. Exchange of cobaltamine complex ions. H. L. Bench, H. B. Weisblatt, and R. H. Winget. AECD-2670, July 20, 1949. Decl. Aug. 24, 1949. 9p.

In the equilibrium exchange of Nalcite HCR (Dowex 50) synthetic ion exchange resin with complex Co cations having approximately the same ionic radius and a positive charge of one, two, and three, respectively, ion radius is the predominant factor influencing the exchange capacity and variation of ionic charge has little or no effect on the exchange. The average number of millimols exchanged with 1 g of resin is 1.30 for the ion with a triple charge, 1.45 for the ion with charge two, and 1.35 for the univalent ion.

1337 A multi-column countercurrent molecular still. Samuel L. Madorsky. AECD-2674, June 30, 1949. Decl. Aug. 23, 1949. 15p.

A 10-column countercurrent molecular still, based on refluxing by gravity feeds and circulation of the liquid by means of magnetic pumps, is described. Each column consists of a concentric evaporator having a surface of 300 Cm^2, surrounded by a water-cooled condenser. All the condensates move by gravity from column to column in one direction and all the residues move similarly in the opposite direction, thus producing countercurrent refluxing of the liquid. The 10-column still comprises 19 practical plates or 13 theoretical plates, calculated on the basis of a "cut" of 2. A magnetic glass pump, designed to operate in a vacuum, is also described. Schematic diagrams, a photograph, and a flow sheet of the still are included.

1338 The extraction of hafnium from nitric acid solutions with thenoyl trifluoroacetone. J. P. McBride. AECU-399, Aug. 9, 1949. 32p.

Data are presented which indicate that the extraction of Hf from 0.5 to 3.5 M HNO_3 with thenoyltrifluoroacetone (TTA) has a third power dependence on H ion and a fourth power dependence on TTA corresponding to the equation: $Hf(OH)^{+3}_A + 4HT_B \rightleftharpoons HfT_{4B} + 3H_A + H_2O$. The small deviations from fourth power dependence on TTA are explained by the formation of an aqueous soluble Hf-TTA complex by the reaction: $Hf(OH)^{+3}_A + HT_B \rightleftharpoons HfT^{+3}_A + H_2O$ with an equilibrium constant, k_t, equal to 15.5. An apparent or effective value for the molar H

CHEMISTRY (continued)

ion activity coefficient has been calculated for use in calculations involving the extraction of other metallic species from nitric acid with TTA. A semi-empirical expression has been derived for the calculation of the distribution ratio of Hf between benzene phases 0.005 to 0.1 M in TTA and aqueous phases 0.5 to 3.5 M in nitric acid.

1339 Effect of high-voltage x-rays and cathode rays on vitamins (riboflavin and carotene). Samuel A. Goldblith and Bernard E. Proctor. *Nucleonics 5*, 50-8(1949) Aug.

The effects of high-voltage, electrostatically produced x-rays and cathode rays (electrons) on pure solutions of riboflavin and the effects of such cathode rays on pure solutions of carotene were determined. It was found that riboflavin was radiosensitive to both cathode rays and x-rays. Carotene was radiosensitive to cathode rays, 50% of a petroleum ether solution containing 100 μg of carotene per ml being destroyed by 0.66×10^6 rep. The destruction of both riboflavin and carotene increased with the dilution of the solutions. This is indicative of an "indirect action" of the ionizing radiations upon these two vitamins. Since the carotene was irradiated in a solution of petroleum ether, the activated water hypothesis cannot be used to explain this finding. Presumably, other compounds were formed by the irradiation of the petroleum ether. From spectroscopic evidence it would appear that lumichrome may be formed when riboflavin is irradiated by high-voltage cathode rays. There is evidence also that some of the riboflavin molecules are broken down into smaller fragments. 17 references.

1340 Instrumental and Doppler broadening in the Fabry-Perot interference pattern of close doublets: second edition. P. M. Griffin and J. R. McNally, Jr. AECU-400, May 12, 1949. 21p.

The intensity distribution in Fabry-Perot interference patterns as a function of instrumental and Doppler broadening is discussed. A brief summary of previous work on the effect of Doppler broadening on interference fringes is given. An expression is developed for the intensity distribution due to a close doublet as a function of the temperature of the source, order of interference, reflection power of the interferometer plates, and the ratio of peak intensities of the two lines. This expression is applied to the green lines from a hypothetical source containing electromagnetically separated Hg^{204} with Hg^{202} as the principal impurity and investigated under the following conditions: source temperatures of 77° and 300°K; reflection powers of 0.80, 0.85, and 0.90; orders of interference corresponding to plate separations of 1, 2, and 3 cm. From these data conclusions are drawn concerning the maximum tolerable percentage of Hg^{202} in a Hg^{204} source if the green line from this source were to be used as an acceptable standard of wavelength. A report on the progress being made in the Y-12 plant in Oak Ridge on the enhancement of Hg isotopes is given. An electrodeless discharge tube containing approximately 7 mg of Hg in which the Hg^{202} content was 88.2% has been constructed. The Fabry-Perot interference pattern of the green line from this source, taken with a plate separation of 15 mm, is shown. This document is a revision of AECD-2473.

1341 Paper chromatography in synthetic organic chemistry. Microgram scale syntheses of labeled monoidotyrosine, diiodotyrosine, and thyroxine. R. M. Lemmon, Wimfred Tarpey, and Kenneth G. Scott. AECU-412, July 8, 1949. 13p.

Syntheses of I^{131}-labeled moniodotyrosine, diiodotyrosine, and thyroxine of high specific activity have been carried out on a microgram scale. The products have been separated from their reaction mixtures and identified through the use of paper chromatography. A semi-quantitative estimation of the products has been made by spectrophotometry. Preparation of 3, 5-diiodo^{131}-L-tyrosine and monoiodo^{131}-L-tyrosine based on the iodination of tyrosine by the method of Harington, *Biochem J. 22*, 1429(1928), and the oxidation of radioactive iodide to I with K iodate by the method of Horeau and Süe, *Bull. soc. chim. biol. 27*, 483(1945), are described. The chromatography of the mono- and diiodotyrosine reaction mixture was carried out by developing the paper in both directions with a butanol-acetic acid-water solvent. I^{131}-labeled thyroxine was prepared by means of the exchange reaction with inorganic iodide described by Frieden et. al., *Science 107*, 353(1948). The chromatography of the thyroxine reaction mixture was accomplished using the solvent indicated above. In later work the chromatogram was also run in the second direction. In addition a 7:1 butanol-water solution was used instead of butanol-acetic acid developer. Details of spectrophotometric analysis are indicated.

CHEMISTRY (continued)

1342 Isotopically labeled nucleic acid from yeast. Frederick J. Di Carlo, Alfred S. Schultz, Paul M. Roll, and George Bosworth Brown. *J. Biol. Chem. 180*, 329-31(1949) Aug.

It was demonstrated that yeast may be employed as a convenient source of isotopically labeled compounds of biochemical interest. In this work yeast was propagated on a medium containing excess N^{15} in the form of ammonium sulfate. Isotopically labeled nucleic acid was isolated, and it was shown that the isotopic N was uniformly distributed throughout the purines and pyrimidines.

1343 Preparation of 1-butene labelled with C^{14} in the four position. R. B. Regier and R. W. Blue. *J. Org. Chem. 14*, 505-8(1949) July.

1-Butene of high purity has been prepared in 63% yield from methyl alcohol containing C^{14}. The method and apparatus are described in detail and an examination of the by-products is included.

1344 Chambers Works process for the manufacture of fluorine in East Area carbon anode cells. A. C. Stevenson. AECD-2671, Jan. 18, 1945. Decl. Sept. 30, 1948. 5p.

Elementary F is produced by the electrolysis of anhydrous HF from electrolytic HF-KF solution containing 38-40% anhydrous HF. F is liberated at the carbon anode and H at a steel cathode. The chemical yield is 81% of theory; current efficiency is 90% of theory. The equipment consisting of electrolysis cells, HF vaporizers and storage tanks, electrolyte storage tanks, and heat exchangers is briefly described. Cell loading, installation, and operating procedures are discussed.

1345 The physical properties of fluorolube and chlorofluoroterphenyl oil. J. L. Gabbard, S. Blumkin, V. E. Anderson, J. T. Dietrich, J. H. Jamieson, W. W. Lemarr, and N. C. Orrick. AECU-410, Aug. 5, 1949. 28p.

A sample of fluorolube approximating $C_{21}F_{44}$ in average composition, a sample of the foreshot from the distillation of this oil, and a sample of a chlorofluoroterphenyl oil have been fractionated in molecular stills. The densities, viscosities, refractive indexes, all at 60°C, and the number average molecular weights of the fractions obtained were determined. The derivation of useful empirical relations from the data is not possible, since all three of the oils were evidently very complex mixtures. The average composition of fluorolube does not correspond to a completely fluorinated paraffinic structure, nor does that of the chlorofluoroterphenyl oil correspond to a terphenyl configuration. Temperature coefficients of the refractive index for a number of fractions of the fluorinated hydrocarbon oil and the chlorofluoroterphenyl oil were determined between 25 and 60°C, and were found to be constant with temperature, but to some inverse function of molecular weight. The vapor pressures from 25 to 100°C of three fluorolube fractions were determined and linear equations relating the logarithm of the pressure to the reciprocal of the temperature were derived. The heats of vaporization of these fractions were calculated from the data.

1346 The vapor pressure and heat of sublimation of graphite. O. C. Simpson, R. J. Thorn, and G. H. Winslow. AECD-2680, May 6, 1949. Decl Aug. 25, 1949. 85p.

This report is a progress report on current measurements at the Argonne National Laboratory of the heat of vaporization and vapor pressure of graphite. It supersedes report AECD-2110 in the sense that it includes all basic data reported therein as well as more recently acquired data. In addition the present report contains a more detailed and critical evaluation of the uncertainties in the results. The data have been obtained by collecting graphite vapor on a quartz target placed above a heated graphite cylinder. The measurements extended from 2300°K to 2500°K. The heat of sublimation was obtained by measuring the rate of deposition of the vapor on the target with the aid of an optical pyrometer. The vapor pressure was measured by weighing the heavier deposits. The vapor pressure was used to make an independent calculation of the heat of sublimation with the aid of data for the specific heat of solid graphite. To date attempts have been made to estimate the vaporization coefficient; but other quantities which could seriously affect the calculated values of the heat of sublimation, the vapor pressure, and the vaporization coefficient, such as the sticking coefficient on the target and the amount of re-evaporation from the walls of the apparatus, are still under investigation. They are discussed in the Addendum. The present results are 174.1 ± 2.1 kcal/mole for the heat of sublimation to the monatomic form and 7.7×10^{-5} mm Hg for the vapor pressure at 2500°K.

CHEMISTRY (continued)

1347 Determination of the average atomic weight of rare earth mixtures. Archie G. Buyers, Elizabeth B. Mohr, L. F. Audrieth, and R. A. Johnson. University of Illinois. Aug. 1, 1949. 42p. (NP-995).

Statistical treatment of average atomic weight data obtained by the use of potassium permanganate for determination of rare earth oxalates has demonstrated that the operation primarily responsible for variations of atomic weights within a given series is the ignition of the oxalate to the oxide. Probability calculations have shown that, if three determinations of average atomic weight are performed by the standard permanganate procedure, the mean of three atomic weight values will not deviate from the true mean by more than ± 1.28 atomic weight units in 95% of the cases. Similarly, if four determinations are carried out, the mean of the four atomic weights will not deviate from the true mean by more than ± 0.82 atomic weight units, again in 95% of the cases.

It has been shown that average atomic weight determinations by evaluation of an oxide-oxalate ratio, cerate method, may be carried out by replacing the permanganate titration of oxalate with a cerate titration. An analysis of variance has revealed the cerate atomic weight determination to be precise within the following limits: if three samples are used, the mean value of the three will not deviate from the true mean by more than ± 2.28 atomic weight units, and if four samples are used, the mean value of the four will not deviate by more than ± 1.45 atomic weight units from the true mean for 95% of the cases. The "t" test has indicated no significant difference between the permanganate and cerate titration of oxalate ion. Therefore, atomic weights of rare earth mixtures can be determined by evaluation of a rare earth oxide-oxalate ratio where the oxalate content is determined by either a permanganate or cerate titration. However, comparison of calculated variances or "fiducial limits" for both methods reveals the permanganate procedure to be the more precise.

An analysis of variance performed upon the atomic weight data based on a phosphate precipitation (involving the oxide/H ion ratio) has revealed that three determinations will yield a mean of the three which will not deviate from the true mean by more than ± 3.67 atomic weight units. The "t" test when applied to paired phosphate and permanganate atomic weight values has shown that there is a significant difference between the determinations in 95% of the cases when performed upon the same rare earth materials. Concentration of rare earth ion, method of precipitation of the rare earth phosphate, and the buffering action of excess dihydrogen phosphate reagent have been shown to cause measurable discrepencies in the determination of average atomic weights by the phosphate procedure. Attempts to eliminate incomplete back titration of H ion have met with no success. The phosphate method for determination of average atomic weight or rare earth mixtures is, therefore, not considered reliable because of (a) wide variation in precision as shown by the "fiducial limits", (b) the fact that the "t" test indicates a significant difference in phosphate and permanganate atomic weight values, and (c) imcomplete titration of released H ion.

1348 Lanthanon (rare-earth) sodium sulphate precipitations. J. K. Marsh. *Nature 163*, 998-9(1949) June 25 (Letter to the editor).

A method is described for precipitating the "soluble" double sulphates of the light (Ce group) lanthanons, leaving the heavy group of Y in solution, by "salting-out" with brine and adding sodium sulphate. The use of brine is particularly advantageous in fractionating middle (Gd) and heavy (Y) lanthanon mixtures.

1349 The thermodynamic properties and equilibria at high temperatures of the compounds of plutonium. Leo Brewer, LeRoy Bromley, Paul W. Gilles, and Norman L. Lofgren. AECD-2661, Feb. 1, 1949. Decl. Aug. 1949. 63p.

Values of the thermodynamic data for Pu compounds are given in four tables in Part I. Table 1 gives melting, vapor pressure, and boiling data. Table 2 gives the constants for the free energy of vaporization equation together with heat and entropy of vaporization at the boiling point. Table 3 gives values of the free energy function $\frac{\Delta F - \Delta H_{298}}{T}$ and ΔH_{298}, the heat of formation. Table 4 gives the heat, free energy, and entropy of formation for the aqueous ions. Part II contains the references and the discussion of the high temperature chemistry of the compounds considered. Part III presents five graphs to show the equilibrium concentrations of halogen or halide in plutonium and halogen systems at three different pressures, one atm, 10^{-3} atm, and 10^{-6} atm.

CHEMISTRY (continued)

1350 The design and construction of sensitive fluorophotometers. Part I. Principles. G. R. Price. AECD-2677, Apr. 1948. Decl. Aug. 23, 1949. 51p.

Fluorophotometers of high sensitivity and of use over a concentration range of at least 1,000,000 have been designed for the determination of U. The basic optical system and its geometry, the photoelectric system, and construction principles are discussed in detail.

1351 Note on the structure of uranium. Joseph S. Lukesh. AECU-398, nd. 3p.

The document is reproduced below in its entirety.

The structure of the low temperature or alpha phase of uranium has been studied by Wilson (1933) and by Jacob and Warren (1937). In both investigations, the powder technique was used. Wilson reports a monoclinic cell with the following constants: a = 2.829 A, b = 4.887, C = 3.308, β = 63° 26′ (116° 34′). Jacob and Warren observed additional lines and deduced an orthorhombic cell with a = 2.852 A, b = 5.865, c = 4.945. The space group is D_{2h}^{17} – Cmcm. Atoms are in the 4c position and satisfactory intensity agreement was found with the y parameter equal to .105 ± .005.

Because of the uncertainties inherent in the interpretation of powder photographs of low symmetry, it was felt advisable to confirm the structure using single crystals. Rotation and Weissenberg photographs are consistent with the cell and space group of Jacob and Warren. Intensities are in substantial agreement with those calculated from the suggested structure. No refinement of the parameter is possible because of the high absorption. As a typical example, calculation gives 002 ≫ 006 > 004 whereas it is observed that 006 ⋙ 002 > 004. The apparent reversal is due to the fact that, for Cu radiation, 006 is a high theta reflection and is relatively unaffected by absorption.

It is of interest to note that the cell deduced by Wilson can be considered as contained in that of Jacob and Warren. The axial relations can be expressed as follows: $a_{mono} = a_{ortho}$, $b_{mono} = c_{ortho}$, $c_{mono} = \frac{a_{ortho} + b_{ortho}}{2}$ – the monoclinic angle, β, is that between the a axis and the a + b direction. References: Wilson, T. A., *Physics* 4, 148(1933); Jacob, C. W. and Warren, B. E., *J. Am. Chem. Soc.* 58, 2588(1937).

1352 Solvent extraction of inorganic ions. L. G. Bassett, S. E. Wiberley, and J. Savolainen. AECU-402, Aug. 1, 1949. 15p.

Infrared absorption data on hydrochloric acid, uranyl nitrate, and ferric chloride in aqueous media using AgCl windows are reported. The shift of the H-Cl fundamental in diethyl ether has been determined as 495 ± 10 cm^{-1} using the NaCl prism. More precise determination of this value will be made as soon as the LiF prism is available. Initial data on the refractive index of solutions of ferric chloride in hydrochloric acid are reported. Further investigation of other physical properties of these solutions are necessary before any correlation can be made with the infrared absorption data.

1353 Semi-micro gravimetric determination of uranium. W. W. Harris, Ella Mae Baer, and E. D. Marshall. AECU-408, June 29, 1949. 11p.

A modified procedure is described for the determination of U in U compounds using an ammonium hydroxide precipitation followed by conversion of the ammonium hydroxide precipatate to urano-uranic oxide (U_3O_8) for weighing. With urano-uranic oxide samples weighing from 20 to 50 Mg. a precision of 0.28% U at the 95% confidence level is attained. Interferences include carbonate, organic complexing agents, and cations and anions precipitated by ammonium hydroxide.

1354 The magnetic susceptibilities of some tetravalent uranium fluorides. Norman Elliott. *Phys. Rev.* 76, 431-2(1949) Aug. 1 (Letter to the editor) (See also AECD-1896 and NSA 1-1076).

The magnetic susceptibilities of UF_4, KUF_5, K_2UF_6, and Na_3UF_7 have been measured by the Gouy method over a temperature range of approximately 74°K to 300°K. The UF_4 was prepared from UO_2 by treatment with anhydrous HF, and the complex salts were prepared by the fusion of UF_4 with stoichiometric quantities of the alkali or alkaline earth fluorides. This was done in a Pt crucible in an HF atmosphere, as described by Zachariasen, *J. Am. Chem. Soc.* 70, 2147(1948). With the exception of K_2UF_6, these substances obeyed the Curie-Weiss law $\chi = C/(T + \theta)$ over the whole temperature range for the investigation. K_2UF_6 followed the Curie-Weiss law down to 198°K, but deviated below this temperature. At 76°K its susceptibility is

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8.6% smaller than that given by the Curies-Weiss equation. These data are given in tabular form along with the experimentally calculated values for the magnetic moments of the free ions. The values obtained for the latter are in good agreement with the theoretical value calculated by Van Vleck ("Theory of electric and magnetic susceptibilities," Oxford University Press, New York).

ENGINEERING

1355 Radioactive tracers in mineral engineering problems and particularly in flotation. A. M. Gaudin and P. L. de Bruyn. *Can. Mining Met. Bull. 42*, 331-7(1949) July (See NSA 1-716 and 1-769).

The use of C^{14} as a tracer in flotation collectors is described and the results of several experiments are presented. The authors briefly state that a general study of tracers in mineral engineering is underway using the radioisotopes of Ag^{110}, As^{74}, Sr^{90}, Ba^{140}, and S^{35}. 13 references are included.

1356 Effects of different gases on Phillips gauges. L. R. Foote. AECD-2672, Jan. 17, 1944. Decl. Aug. 23, 1949. 14p.

The relative effects of various gases on the sensitivity of two Phillips ionization gauges (PIG) with different geometry and a Distillation Products ion gauge (DPI) have been determined using a McLeod oil gauge as a standard. The results are tabulated below.

PRESSURE	1×10^{-4} mm Hg			2×10^{-4} mm Hg		
Gauge	PIG #1	PIG #2	DPI.	PIG #1	PIG #2	DPI.
He	0.26	0.21	0.19	0.27	0.21	0.20
H	0.54	0.40	0.535	0.50	0.39	0.58
O	0.97	1.0	0.96	0.96	0.97	0.92
N	1.0	1.0	1.0	1.0	1.0	1.07
Air	1.0	1.0	1.0	1.0	1.0	1.0
Water Vapor	1.45	1.58	1.96	1.47	1.47	2.25

The apparatus used and experimental techniques and difficulties are discussed.

1357 A tilting oil McLeod gauge. Frank Kirby. AECD-2673, Nov. 6, 1943. Decl. Aug 23, 1943. 6p.

A gauge has been constructed whose working range is from 1×10^{-6} to 1×10^{-2} mm of Hg. It uses a 1.55 mm capillary and a 300 ml bulb; the oil reservoir is 500 ml. The glass parts are mounted on a still frame which can be rotated through an angle of approximately 45°. A Kerotest valve is fastened to the steel frame and moves the gauge. The gauge must be kept under vacuum when not in use to prevent air absorption by the oil. Three low vapor pressure oils have been used: butyl sebacate, butyl phthlate, and Litton Oil "C." Some advantages of the gauge as compared with the conventional type Hg gauge are greater sensitivity, lightness, and better reproducibility of readings. Two disadvantages are the necessity of keeping the gauge under vacuum when not in use, and the sticking of oil at the bottom of the capillary. This second disadvantage can be overcome by using a small heater at the bottom of the capillary.

1358 The halide torch method of leak detection. A. C. Schmidt. AECD-2678, Sept. 6, 1943. Decl Aug 23, 1949. 5p.

The test equipment consists of a burner operated with acetylene or other halide-free gases with an air intake through a 3-ft tube which is the leak probe. Above the burner flame is a Cu plate which becomes red hot. The leak detection test involves introducing Freon or other halogen containing gases into the system being tested and probing its surface with the leak probe. If a trace of the halogen containing gas escapes from the system it is taken up by the air intake, and reacts with the hot Cu plate giving a bright green flame characteristic of Cu halides. The The author claims that the test is as sensitive and rapid as the soap bubble test,and is suitable for the locations of leaks in places where soap bubbles cannot be seen. No inflamnable gas is necessary. No data is available on the relative sensitivities of this test, and the "gassing" test where the system is evacuated and external applications of H or illuminating gas in the vicinity of leaks give rise to increased internal pressures as evidenced by ionization gauge readings. A schematic diagram of the apparatus is included.

ENGINEERING (continued)

1359 A universal coupling for use in vacuum systems. R. I. Garrod and K. A. Gross. *J. Sci. Instruments 26*, 279(1949) Aug. (Laboratory and shop notes).

A universal coupling for use on demountable vacuum systems (used for producing pressures of the order of 10^{-5} mm of Hg) designed to overcome the objections associated with wax or plasticene seals is described. The coupling unit consists essentially of a series of flat circular plates, with different sizes of holes to accommodate a range of diameters of connecting pipes, combined with neoprene rings of circular section as the flexible sealing elements. The unit incorporates the following desirable features: (1) ready adaptability to different sizes of glass or metal pipes; (2) flexibility in the coupling to permit self-alignment of the various elements in the vacuum system; (3) the minimum area of the sealing material exposed to the interior of the vacuum system; (4) simplicity of construction, so that several units may be included as standard items of laboratory equipment without undue expense.

MINERALOGY, METALLURGY AND CERAMICS

1360 Radioactivity of ocean sediments. VII. Rate of deposition of deep-sea sediments. Wm. D. Urry. *J. Of Marine Research (Sears Foundation) 7*, 618-34(1948) (See also NSA 2-1920).

The rate of sedimentation can be determined from Ra content of the sediments, since variations in Ra content occurred during the establishment of radioactive equilibrium in deep-sea deposits. Rates of deposition as a function of time (for the past half million years) are reported for red clay, globigerina ooze, foraminiferal marl, glacial marine deposits, and calcareous blue mud. The results agree well with those of other methods.

1361 A process for hot pressing beryllium powder. A. U. Seybolt, R. M. Linsmayer, and J. P. Frandsen. AECD-2679, nd. Decl. Aug. 18, 1949. 23p.

Beryllium hot pressed powder compacts of practically theoretical density have been made up to about 12 in. in diameter and 4 in. thick. Pressing conditions using a metal-lined graphite die have usually been the following: temperature, 1100°C; pressure, 750-1000 psi; time at maximum temperature and pressure, 30-45 min. Radiographs show such Be to be quite uniform and structurally dense, a finding corroborated by metallographic examination. However, there are numerous small flux inclusions and other inclusions, reflecting the lack of high purity in the raw material used. Tensile test data indicate properties comparable to Be fabricated from castings.

1362 A general literature survey of diffusion in metals. R. O. Hutchison. AECU-401, June 10, 1949. 39p.

This survey gives reference to the more prominent literature available on diffusion in metals. These 45 articles were abstracted or summarized according to their usefulness in an investigation being carried out by the author. The references were obtained through the use of the common indexes such as Industrial Arts Index, Engineering Index, Chemical Abstracts, and other bibliographies available to the author. The references are listed alphabetically according to author.

1363 Measurement of intensity of x-rays diffusely scattered by [using] a crystal with an interference counter tube with single impulse counts. Gustav Wagner and Albert Kochendörfer. *Z. Naturforsch. 3a*, 364-5(1948).

The intensity of diffusely scattered x-rays can be measured by single-impulse counts obtained by using a crystal with an interference counter tube. In researches on the effect of plastic deformation of metals upon fogging intensity, this method was found to be superior to the photographic registration of background scattering..

1364 A mechanism for dimensional changes in crystals subjected to fluctuating temperature. J. C. Fisher. General Electric Research Laboratory Report RL-157. Jan. 1949. 9p.

A specimen of Bi has been used to estimate the change in dimensions of metallic crystals subjected to alternate heating and cooling. Atoms flow into the crystal parallel to the c-axis at 150°C and out perpendicular to the c-axis at 265°C. There must be, therefore, a net current of matter through the crystal and the shape of the crystal must change. It is predicted that the dimensional changes may be as great as 0.01 or 0.1% per temperature cycle for metallic crystals having anisotropic diffusion rates.

MINERALOGY, METALLURGY AND CERAMICS (continued)

1365 A tentative titanium-nickel diagram. J. R. Long, E. T. Hayes, D. C. Root, and C. E. Armantrout. *U. S. Bur. of Mines, Repts. Invest. R. I. 4463*, 13 pp. (1949) Feb. (See also NSA 3-111).

A tentative Ti-Ni diagram up to 40% Ni is presented. The major portion of the data is concerned with delineation of the solid-phase equilibria, particularly the β-Ti solid solution and its eutectoidal decomposition. Little attempt was made to determine the liquidus or solidus lines at very high temperatures, but the data do allow a tentative approximation of their positions in the range from 1,200°C down to 960°C.

1366 Titanium and zirconium corrosion studies – common mineral acids. E. A. Gee, L. B. Golden, and W. E. Lusby, Jr. *Ind. Eng. Chem. 41*, 1668-73(1949) Aug.

Ti is resistant to sulfuric and hydrochloric acids only at low concentrations but is almost completely resistant to all concentrations of nitric acid. As a corrosion resistant metal in hydrochloric and nitric acids, its general behavior is comparable to Type 316 stainless steel. However, it is somewhat less resistant than the latter in sulfuric acid. Zr is relatively resistant to all concentrations of hydrochloric, nitric, and phosphoric acids, although it is attacked by high concentrations of sulfuric acid at elevated temperatures. Nine tables are included which show the corrosion rates of Ti and Zr in the various acid mediums.

PHYSICS

1367 Cosmical zero, and the origin of radiation and dense matter. D. Stanley-Jones. *Nature 164*, 279-80(1949) Aug. 13 (Letter to the editor).

An argument is presented against Haldane's quantum theory of the origin of the solar system, *Nature 155*, 133(1945). Haldane has assumed that zero-points obtained by extrapolating backward from the known expansion of the universe and from the known degradation of energy coincide. It is shown that this assumption contradicts the fundamental laws of entropy in thermodynamic theory, and it is suggested that the beginning of the expansion of the universe should be placed at the beginning of the process of galactic condensation, and that it was separated from the first creation of photons by the time necessary for individual star formation.

1368 Current ideas about mesons. Conway W. Snyder. *Nucleonics 5*, 42-52(1949) July.

The experimental facts about mesons which have led to the identification of the meson-types are reviewed, and the properties of mesons are summarized and correlated with a few of the associated theories. 7 figures.

1369 Evidence for the stellar origin of cosmic rays. M. Ryle. *Proc. Phys. Soc. (London) 62A*, 491-8(1949) Aug. 1.

Several authors have suggested the possibility that cosmic rays are due to the acceleration of charged particles in the atmospheres of certain stars. Recent observations at radio frequencies have provided some evidence in support of this hypothesis which is reviewed. The observations have shown that at least part of the radio-frequency radiation from the galaxy is emitted by discrete sources of small angular diameter. Measurements of the intensity of the radiation from these sources, and of the time variations of the intensity, indicate that the sources emit radio waves as if they were at a temperature of more than 10^{14}°K. It is concluded that this intense radiation cannot be caused by the coherent oscillation of a large number of electrons, but must be due to a genuine electron temperature of about 10^{10}°K(corresponding to a mean electron energy of 10^{10} ev). The existence of this electron temperature indicates that in certain stellar bodies there are mechanisms capable of accelerating particles to cosmic ray energies. A previous theory of the emission of radio waves from the sun is extended to other stellar bodies. It is concluded that a star having a surface magnetic field strength and a peripheral velocity somewhat greater than those which have so far been observed could emit radio waves having the observed intensity. A star of this type could also accelerate charged particles to cosmic ray energies. The small visual brightness of the sources of radio waves suggests that these bodies may be characterized by small visual opacity or small photospheric temperature. It is suggested that the difference between the angular distribution of cosmic rays and of the radio waves from the galaxy is due to the deflection of cosmic ray particles by magnetic fields. In addition to previous theories of a general magnetic field in the galaxy, it is shown that the scattering produced

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by the magnetic fields of the distributed sources themselves should be sufficient to produce an isotropic distribution of cosmic rays at the earth even though the sources may show a marked concentration near the galactic equator. 17 references.

1370 Interaction of mesons with the electromagnetic field. W. H. Furry and M. Neuman. *Phys. Rev. 76*, 432(1949) Aug. 1 (Letter to the editor).

In terms of the formalism of Duffin and Kemmer, *Proc. Roy. Soc. (London) 173A*, 91(1939), a Lorentz gauge and charge invariant theory of the interaction of a meson with an electromagnetic field has been formulated. By means of the method used by Schwinger, *Phys. Rev. 74*, 1439(1948), the longitudinal components of the electromagnetic field were eliminated from the Hamiltonian. Following a unitary transformation the resulting second-order Hamiltonian was analyzed into vacuum, photon, meson self-energy terms, and terms representing the coupling of photons with mesons and the interaction between mesons. The vacuum self-energy was shown to be a constant; the photon self-energy could be taken to vanish, if certain ambiguous integrals were suitably evaluated; the meson self-energy terms when transformed back to the original Kemmer equation could be interpreted as mass correction terms. The polarization of the mesic vacuum by a given current distribution was also investigated. For a scalar meson the polarization kernel is of second order in the derivatives. The polarization kernel of the vector meson consists of two terms, separately conserved and gauge invariant. The first is formally identical with the polarization kernel of a spinless particle, the second is of fourth order in the derivatives. It is suggested that the current associated specifically with the vector meson be regarded as observable beginning with derivatives of the external potential of higher order than those appearing in the polarization kernel, the formal procedure being the same as that used in case of the electron and scalar meson. The formulas obtained are stated in explicit form.

1371 Large cosmic stars in electron sensitive emulsions. E. Pickup and L. Voyvodic. *Phys. Rev. 76*, 447-8(1949) Aug. 1 (Letter to the editor) (See also NSA 2-1192).

In examining some Ilford G5 emulsions, flown for 185 hr at an average height of 14,000 ft, examples of μ-meson decay were observed, indicating that the emulsion was sensitive to minimum ionization. It is also apparent that many of the stars show tracks which could not have been detected with the C2 emulsion previously used. Some of the interesting large stars observed are discussed and mosaic photomicrographs are shown of the following: (1) a 31-pronged star with a downward cone of light tracks, (2) μ-meson electron decay, and (3) a section of track showing the grain density caused by the passage of a 9-Mev π-meson. It is concluded that the most probable hypothesis to explain the occurrence of long star tracks observed (which were of minimum density) would be that of multiple meson production in the nuclear break-up. Further experiments are planned to establish the identity of the lightly ionizing particles observed.

1372 The loss of energy of slow negative mesons in matter. R. L. Rosenberg. *Phil. Mag. 40*, 759-69(1949) July.

The previous calculations by Fermi and Teller, *Phys. Rev. 72*, 399(1947), of the rate of loss of energy by negative mesons in matter have been extended to obtain a more detailed calculation of the rate of loss for meson velocities less than the orbital velocity of the electron. The method used, which is attributed to Mott, *Proc. Cambridge Phil. Soc. 27*, 553(1931), is particularly suited for slow-moving heavy particles. The only energy loss considered is that due to ionization. Curves of the cross section for capture as a function of k (where k^2 is the energy of the ejected electron) are shown for velocities of .1, .25, .5, and 1 (where v is given in units of the velocity of the electron in the Bohr orbit). A curve of the total cross section as a function of the velocity is also given. From these it is inferred that when $v < 1/10$ the meson is most likely to be captured, whereas for $v > 1/10$ it is unlikely that the meson will be captured by ionization. It may be further inferred that when captured the orbit of the meson will not have an energy numerically greater than 13 ev, and as the meson mass is about 200 m it will be captured into an outer orbit provided always that capture is by ionization only, without radiative loss by the meson. The curve of the rate of loss of energy as a function of the reciprocal of the velocity is shown and discussed.

1373 The mesodisintegration of the deuteron. C. Marty and J. Prentki. *J. phys. radium 10*, 156-64(1949) May (in French).

The capture of low-energy π mesons by deuterons has been studied by means of the mixed symmetric theory of Möller and Rosenfeld. After considering the capture of a free meson (positive, negative, or neutral), the absorption of a negative meson from a K-orbit is treated. The results obtained are in agreement with the previously published calculations of various authors, Fermi,

PHYSICS (continued)

et. al., *Phys. Rev.* 71, 314(1947). With respect to the relative importance of the two modes of absorption, the numerical values of the effective cross sections or the capture-probabilities are given for the case of a meson of mass $m_\pi = 286m_e$. The possibility of demonstrating the existence of a neutral π meson on the basis of the dissociation of the deuteron is discussed briefly.

1374 Note on meson production. H. W. Lewis. *Phys. Rev.* 76, 566(1949) Aug. 15 (Letter to the editor).

The previously derived formulas, *Phys. Rev.* 73, 127(1948), which describe the multiplicity and angular distribution of mesons produced in nuclear collisions involving extremely high energies have been rewritten so that they can be applied with more justification to the region of intermediate primary energies (5-15 Bev).

1375 Nuclear transmutations produced by cosmic-ray particles of great energy. Part I. Observations with photographic plates exposed at an altitude of 11,000 feet. R. H. Brown, U. Camerini, P. H. Fowler, H. Heitler, D. T. King, and C. F. Powell. *Phil. Mag.* 40, 862-81(1949) Aug. (See also NSA 2-1068 and 2-1195).

A description is given of the results of observations made with "electron-sensitive" emulsions exposed at a height of 11,000 ft. It is shown that approximately half the nuclear disintegrations in which many charged particles are emitted are produced by particles of charge (e), moving at relativistic velocities. The other half of these "stars" must be attributed to a neutral radiation. The directions of motion of most of the "primary" particles are inclined to the vertical at angles less than 40°. The particles appear to be able to pass through nuclei, imparting energy to the nucleons so that the nuclei evaporate, and having a 50% probability of suffering a change of charge (e) in each encounter. If the energy of the incident particle is sufficiently great, "showers" of charged particles are produced. Photo-micrographs are given of characteristic examples of "stars" of different types. 15 figures. 4 tables, 8 photographic plates.

1376 On the latitude dependence of nuclear disintegrations and neutrons at 30,000 feet. J. A. Simpson, Jr. R. B. Uretz. *Phys. Rev.* 76, 569-70(1949) Aug. 15 (Letter to the editor).

Preliminary measurements of the change in the rate of production of low energy nuclear disintegrations between geomagentic latitudes 40°N and 55°N have been made at 30,000 feet pressure altitude in a B-29 aircraft using electron collection ionization pulse chambers. Since both fast and thermal neutrons in the atmosphere at this altitude display a latitude dependence much larger than for other components observed in the cosmic radiation, a measurement of nuclear disintegration rates may indicate the extent to which the observed neutrons are associated with these nuclear disintegrations or "star" events. The coincidence-counting arrangement used is described. From tabulated data on the number of nuclear disintegrations recorded at the various latitudes and the calculated factor of increase in the nuclear disintegration rate between 40° and 55°N magnetic latitude it is concluded that the most predominant process for the formation of most of the neutrons in the atmosphere with energies below 20 Mev appears to be the emission of neutrons and protons from nuclear disintegration or "star" events. These star events, in turn, may be produced predominantly by higher energy nucleons. More than a three-fold increase in nuclear disintegration rate between 0° and 55° N magnetic latitude has been obtained and is to be compared with a factor of 3.5 for the neutron densities.

1377 On the mechanism of production of the neutron component of the cosmic radiation. Vanna Cocconi Tongiorgi. *Phys. Rev.* 76, 517-26(1949) Aug. 15.

Experiments have been performed on the neutron component of the cosmic radiation, with a system of BF_3 proportional counters embedded in paraffin, capable of recording neutrons in the energy range between ~ 2 and ~ 15 Mev. The neutron rate recorded with such a detector is due to both neutrons locally produced inside the detector and neutrons produced outside the detector, i.e., in the surroundings and in the atmosphere. The local neutron production is due to a radiation which in the great majority does not consist either of photons or μ-mesons. The intensity of such radiation increases with altitude with a mean free path in air of 120-130 g/cm^2, which is confirmed by the fact that it shows a barometric coefficient $\approx$ - 11% per cm Hg. At mountain elevation (4,000 m) the intensity of this radiation is close to that of the total ionizing cosmic radiation. This suggests that it consists principally of fast neutrons. The locally produced neutrons for the most part produced in multiples, with multiplitiy depending upon the material. In Pb the average multiplicity observed was close to eight, in C smaller than two. The rates of neutron production in different materials are satisfactorily described by a cross section

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proportional to the 2/3 power of the mass number of the material. From the results it is concluded that the main source of all the neutrons present in the cosmic radiation is "stars," though high energy processes like penetrating and extensive showers do contribute to neutron production.

1378 On the origin of heavy cosmic-ray particles. Lyman Spitzer, Jr. *Phys. Rev.* 76, 583 (1949) Aug. 15 (Letter to the editor).

Although it has been suggested, Zwicky, *Phys. Rev.* 55, 986(1939) and *Proc. Natl. Acad. Sci.* 25, 338(1939), that supernovae might produce cosmic rays, with the expulsion of high-speed atoms from the stellar surface, the possibility of the acceleration of small solid particles or dust grains by the pressure of supernova radiation has not been previously considered. The velocities reached would approach the velocity of light and the high speed grains would gradually disintegrate into cosmic-ray particles of the heavier elements. The average density of high-speed atoms in the galaxy has been computed to be 5×10^{-14} per cm^3, yielding a particle flux of about 10^{-4} atom/cm^2/spheradian. This result is consistent with the corresponding observed particle fluxes in the cosmic radiation which, according to B. Peters (informal communication), are 1.0×10^{-4} for $10 < Z < 28$, and 4.3×10^{-4} for O, C, and N. It is noted that while this mechanism may apparently produce an appreciable fraction of the heavy-particle cosmic radiation, it may not be capable of generating particles with energies greater than a few Bev per nucleon.

1379 Production of heavy mesons in cosmic ray stars. J. B. Harding and D. H. Perkins. *Nature* 164, 285-87(1949) Aug. 13.

Previous measurements of the absorption of π mesons in dense matter have permitted the approximate determination of their rate of production and energy spectrum. The experiment consisted of horizontally exposing boxes of Ilford C2 plates, 100μ thick, in a narrow crevasse, ~10 cm wide, in a glacier at 3,650 m. The numbers of heavy mesons coming to rest in the plates, both π^+ and π^- at different depths, are given in tabular form. The mean range is determined as 100-200 gm/cm^2 of ice. It is noted that the experimental results are consistent with the assumption that the direct production of μ-mesons from stars formed in the ice is small compared with the rate of production of the π-mesons. A lower limit has been set on the life-time of the heavy mesons, $\tau_0 > 2 \times 10^{-9}$ sec, in agreement with the results of other observers, Camerini, et. al., *Nature* 162, 168(1948),. The results also indicate that the μ-mesons result from the much more energetic disintegration stars produced in the high atmosphere.

1380 Single production of mesons by gamma-rays near threshold. Leslie L. Foldy. *Phys. Rev.* 76, 372-74(1949) Aug. 1 (See also NSA 3-129).

The cross section for single charged meson production through absorption of a γ-ray in a γ-ray-nucleon collision has been calculated to order e^2g^2 in the charged scalar meson theory (scalar coupling) and charged pseudoscalar meson theory (pseudovector coupling). The nucleon was assumed to be infinitely heavy, thus restricting the validity of the results to γ-ray energies less than a few times threshold. For a free nucleon the threshold for π-meson production is at 155 Mev in the rest system of the nucleon. Close to threshold, in the scalar theory the cross section varies as the three-halves power of the energy above threshold and the angular distribution is of the form $\sin^2\theta$, while in the pseudoscalar theory the cross section varies as the square root of the energy above threshold and the angular distribution of the mesons is approximately isotropic. At energies 50% above threshold, the total cross section is of order 10^{-28} cm^2 in the pseudoscalar theory and of order 10^{-29} cm^2 in the scalar theory.

1381 The τ-meson. Norbert Wagner and D. Cooper. *Phys. Rev.* 76, 449-50(1949) Aug. 1 (Letter to the editor).

Three particles having masses of about 725 m_e have been identified from their tracks in Ilford C2 emulsion exposed to cosmic radiation at altitudes of 90,000 - 100,000 ft. High mass resolution was attained by minimizing the fading of the latent image and confining the observations to a single plate. Fifty-six mesons of residual range greater than 200 microns, including two π-μ-decays, have been found in the single plate that has been analyzed. One of the particles of mass 725 m_e originated in a very high energy nuclear disintegration and was captured at the end of its range. No nuclear events were associated with the other two 725 m_e particles, although both appeared to have reached the end of their range. Taking the mass of the π-meson to be 286 m_e, the mass of the τ-meson was determined from the data as 725 ± 40 m_e. Scattering measurements gave 1500 ± 1000 m_e for the mass of the τ-meson. The scattering measurements are not

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considered to be reliable, since the measurements on protons, π-mesons, and μ-mesons gave inconsistent results. These results indicate that the τ-meson caries a single positive particle of mass between that of the π-meson and the proton. It is suggested that the rarity and instability of the τ-meson may not be as great as previously indicated.

1382 Areas of search coils. J. DePangher, M. Hammond, and M. Seegmiller. AECD-2666, June 19, 1943. Decl. Aug. 15, 1949. 16p.

Three methods have been used in determining the areas of search coils: (1) comparison of galvanometer deflections, (2) use of a long solenoid, and (3) the null method. In method 1 a search coil of area A is compared with a standard search coil of area S in a magnetic field of H oersteds. Each coil is placed in the magnetic field and the change in the number of lines threading each coil when H is reduced quickly to zero results in galvanometer deflections d_S and d_A. By varying the current flowing through the galvanometer, several deflection points are obtained for each coil and current vs deflection curves are plotted. With this data d_A and d_S may be compared for the same magnetic field, and the area of search coil A determined. Method 2 depends upon the use of the calcuable field strength in a long solenoid instead of a standard area coil as was used in Method 1. In Method 3 the search coil of area A is compared with the standard coil of area S where S > A in a magnetic field of H oersteds. The standard coil is rotated to a position where the number of line-turns in its equals the number of line-turns in area A next to it in a uniform magnetic field. The two coils are connected in series with a type R galvanometer so that the voltages developed in each coil as the field changes rapidly are opposite in polarity. At the position of balance no galvanometer deflection will result. The relative advantages and disadvantages of each of the methods are discussed.

1383 An automatic current integrator. M. J. Poole. *J. Sci. Instruments 26*, 113-4(1949) Apr.

It is often useful in nuclear investigations to be able to measure the total charge collected by the target of a positive ion accelerator during observations on a disintegration, when the current to the target is not sufficiently steady to allow a simple current-measuring instrument to be used. The instrument described was designed to fulfil this purpose over a range of mean currents from 2×10^{-9} to 10^{-6} amp. Circuits are incorporated to enable counting apparatus recording nuclear disintegrations to be automatically switched on or off at exact charge intervals.

1384 Equilibrium time of flowmeters. J. A. Huggill. BR-426, May 8, 1949. 3p.

Calculations have been set up to determine the time required for a flowmeter to approach equilibrium to a given accuracy. In a capillary flowmeter of the conventional type (sketched), the pressure is supposed to be atmospheric, and the valve shut. The valve is then opened at the time t= 0, and the time T is calculated, at which the pressure difference has approaced a given fraction of the equilibrium pressure difference.

1385 An instrument for the measurement and time integration of small voltages and currents. I. A. D. Lewis and A. C. Clark. *J. Sci. Instruments 26*, 80-4(1949) Mar.

The instrument described is being used on the cyclotron at the University of Liverpool for the measurement of the beam current flowing on to an insulated target. It permits the simultaneous measurement and time integration of potentials varying between 0 and 0.5 v with an accuracy of 3%. The input impedance and grid current have values $\sim 10^{10}$ Ω and $\sim 10^{-10}$ amp, respectively, and the instrument can thus be used for measurement of currents down to 0.01 μ amp full-scale deflection, by suitable selection from the range of input resistors provided. Currents are read on a microammeter and time integration results are obtained as counts on a standard call register. Ordinary tubes and components are used throughout. A detailed analysis of the Miller type of integrating circuit has shown that, when a larger value of input potential (say 10 v) is available, an accuracy of within 0.2% is expected over most of the range. This has been verified experimentally.

1386 A precision automatic electrometer. N. T. Seaton. *Rev. Sci. Instruments 20*, 500-3 (1949) July.

A triple-range portable electrometer suitable for the precision measurement of currents of the order 10^{-11} to 10^{-14} amp is described. Current is measured in terms of the automatically registered time interval required to charge a condenser up to a certain voltage. The use of negative feedback and special operatiug conditions for the input FP-54 Pliotron allows current to be simply

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determined to within 0.1%. Radio-type batteries, which operate the instrument completely except for a timer, are contained within the amplifier and will last at least 250 hr.

1387 A pressure controller sensitive to 10^{-4} mm. of mercury. John S. Nisbet. *J. Sci. Instruments* 26, 271-3(1949) Aug.

An apparatus is described which maintains constant pressure in a box through which air is flowing. The accuracy of control is within 10^{-4} mm pressure of Hg and the stability within 10^{-4} mm pressure of Hg/hr. The airflow may vary between 0 and 1,800 l/min with the present model. A sealed-bell balanced-beam type of pressure unit is used, arranged to vary the illumination of a photocell. The amplified output from the photocell is used to control the air supply.

1388 Concentration increase of heavy thallium isotope by electrolytic migration in molten thallium chloride. A. Klemm, H. Hintenberger, and W. Seelmann-Eggebert. *Z. Naturforsch.* 3a, 622-4(1948) Aug.-Nov. (in German).

A method is described for determining the concentration of Tl^{205} in a 203/205 mixture by electrolysis of molten TlCl. A separation factor 1.5 was obtained by electrolysis with a current density of 6 amp/cm^2 during eight days, the difference of the migration rates being 0.4%.

1389 The separation of artificial radioactive $_{79}$gold^{198} in unweighable amount from the stable isotope. Wilfrid Herr. *Z. Naturforsch*, 3a, 645-7(1948).

Radioactive Au^{198} in unweighable amounts may be satisfactorily isolated by separation from an organic Au inner-complex compound by the Szilard-Chalmers process. Final cathodic separation is obtained by electrolysis with a 95% yield of separable Au-activity. The use of Pt foil as holder permits the physical investigation of its radiation.

1390 Tabulation of a function. Warren L. Semon. AECU-382, July 1949. 8p.

A tabulation of the function:

$$\Phi(\mu) = \frac{\sqrt{3}}{4}(1+\mu)\exp\left\{-\frac{\mu}{\pi}\int_0^{\pi/2}\frac{\ln\left[\frac{1-\phi\ \mathrm{ctn}\ \phi}{\sin^2\phi}\right]}{\cos^2\phi+\mu^2\sin^2\phi}\,d\phi\right\}$$

as a function μ in twenty equal steps for the range $0 \leq \mu \leq 1$ has been computed.

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1391 Slow neutron velocity spectrometer studies of O_2, N_2, A, H_2, H_2O, and seven hydrocarbons. Edward Melkonian. AECD-2675, Apr. 22, 1949. Decl. Aug. 9, 1949. 41p.

The slow neutron cross sections of free atoms of O, N, and A have been determined to be: O, 3.73; N, 9.96; A, 0.68 barns. Between 1 and 15 ev the N curve shows an $E^{-1/2}$ slope of 0.34 barns per atom. Measurements on these elements have been extended to over 10,000 ev with no resonances observed. Dependence of cross section upon neutron energy from 1-0.003 ev is presented for O, N, H, H_2O, methane, ethane, propane, n-butane, cetane, ethylene, 1,3 butadiene, and liquid n-butane. At the lowest energies, the large observed H cross section is attributed primarily to thermal translational motion of the molecule. The measurements on the hydrocarbons show the effect of the binding of H in various molecules. Comparison with the theories of Bethe and Arley is made. No difference has been detected in cross section measurements on gaseous and liquid n-butane. 19 references.

1392 Inelastic collision cross sections of various elements for 14-Mev neutrons. Donald Davis Phillips. AECU-404, Apr. 1, 1949. 49p.

Inelastic neutron collision cross sections for several elements have been determined using Cu, Al, and P detectors, and neutrons obtained from bombarding a thick tritium target with 220-kev deuterons which have an energy range of 14.0 ± 0.5 Mev. The results are summarized below:

Element	Cu Detector	Al Detector	P Detector
Be	0.82 ± .03	0.16 (+.06 or -.08)	
B (82% B^{10}, 18% B^{11})	0.69 ± .10	0.24 ± .04	
C	0.85 ± .02		
Al	1.06 ± .05	0.62 ± .07	
Fe	1.45 ± .02	1.21 ± .03	0.78 ± .03
Cd	1.89 ± .06	1.66 ± .07	1.14 ± .04
Au	2.51 ± .04	2.06 ± .09	1.47 ± .10
Pb	2.56 ± .05	2.29 ± .04	0.91 ± .06
Bi	2.56 ± .05	2.28 ± .08	1.03 ± .11

Sphere scattering and threshold detectors, neutron sources, and the experimental checks used in the determination are discussed in detail. 26 references.

1393 Introduction to the theory of diffusion and slowing down of neutrons. IV. R. E. Marshak, H. Brooks, and H. Hurwitz, Jr. *Nucleonics 5*, 59-68(1949) Aug. (See also NSA 3-398; 3-773; and 3-1135).

In this, the last paper of the series, improvements on the "age theory" and on the slowing-down density are considered.

1394 Neutrons from C(d,n) N and Cu(d,n)Zn. J. C. Grosskreutz. *Phys. Rev. 76*, 483-6(1949) Aug. 15.

The energy distribution among the neutrons emitted from C and Cu bombarded by 10-Mev deuterons has been investigated by means of proton recoils in photographic emulsions. A description of the method is given. Two excited levels are observed in N^{13} at 2.29 ± 0.12 Mev and 3.48 ± 0.12 Mev, the latter not having been observed previously. The Q for the production of N^{13} in the ground state is found to be -0.29 ± 0.09 Mev. Both the reactions (d,n) and (d,2n) have been identified in the effects occurring when Cu is bombarded by 10-Mev deuterons. Quantitative agreement with the expected energy range of the neutrons from the (d,2n) reaction is found. There is also evidence for some type of level structure in Zn. A discussion is given of a possible interpretation of this structure.

1395 Polarization effects in n-p and p-p scattering. Lincoln Wolfenstein. *Phys. Rev. 76*, 541-2(1949) Aug. 15.

Calculations have been made of the left-right asymmetry to be expected in neutron-proton scattering if polarized neutrons are used. The detection of such an asymmetry would be direct evidence of a tensor force interaction in the scattering. A 4% asymmetry might be expected at 100 Mev using a (p,n) exchange reaction as a source of 20% polarized neutrons. Effects are smaller in proton-proton scattering.

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1396 The thermal neutron absorption cross section of K^{39}. John L. Hansen and John E. Willard. *Phys. Rev. 76*, 577-8(1949) Aug. 15 (Letter to the editor).

A determination has been made of the ratios of the counting rate of K^{40} in samples of KCl which have received neutron exposures of 1.3×10^{18}, 2.3×10^{18}, and 8.1×10^{19} neutrons/cm^2 to the counting rate of ordinary KCl under identical conditions. From these ratios, the neutron exposures, and the percentage abundance of K^{40} and K^{39} in natural K, a value for the thermal neutron absorption cross section of K^{39} has been obtained. A value of $(3 \pm 1.5) \times 10^{-24}$ cm^2 was obtained for the capture cross section of K^{39} for the pile neutrons with which the samples were bombarded. This is in agreement with the value obtained by Lapointe and Rasetti, *Phys. Rev. 58*, 554(1940).

1397 Thresholds for photo-neutron reactions in Mn, Zn, Zr, Mo, Cd, Pr, Nd, Au, Hg, Tl, and Pb. A. O. Hanson, R. B. Duffield, J. D. Knight, B. C. Diven, and H. Palevsky. *Phys. Rev. 76*, 578-9(1949) Aug. 15 (Letter to the editor).

Measurements on thresholds for photo-neutron reactions, using x-rays from the 22-Mev betatron, have been extended to include a number of other elements. The experimental arrangements are similar to those already described, *Phys. Rev. 75*, 542 (1949). Tabulated data are given for the thresholds for production of characteristic radioactivities of the following isotopes: Mn^{55}, Zn^{64}, Zn^{70}, Zr^{90}, Zr^{91}, Mo^{92}, Mo^{97}, Cd^{113}, Sn^{119}, Sn^{124}, Pr^{141}, Nd^{150}, Au^{197}, Hg^{201}, Tl^{205}, and Pb^{207}. In making the calculations it was assumed that the thresholds defined by the neutron yields are those for the isotope of the highest odd mass number of the element irradiated. The binding energies as obtained from semi-empirical relations are shown in the table for comparison. There is fair agreement between the observed and calculated thresholds with the exception of the Zr^{90}, Mo^{92}, and Pr^{141} which have been pointed out as being exceptionally stable nuclei having closed shells of 50 and 82 neutrons, *Phys. Rev. 74*, 235(1948).

1398 The alpha particles emitted in fission. L. L. Green and D. L. Livesey. *Phys. Rev. 76*, 580(1949) Aug. 15 (Letter to the editor).

It is suggested that the recent comments of Marshall, *Phys. Rev. 75*, 1339(1949), with reference to an earlier paper by the authors concerned with the emission of light particles in fission, *Nature 159*, 332(1947), are misleading. The authors refer to a more detailed account of their work, *Proc. Roy. Soc. (London) A 191*, 428(1947), and also note that the recent work of Allen and Dewan, *Phys. Rev. 76*, 181(1949), substantiates their main conclusions.

1399 Fission cross-section of uranium-235 for thermal neutrons. Sukumar Biswas and A. P. Patro. *Indian J. Phys. 23*, 97-106(1949) March.

The cross-section of fission of U^{235} for thermal neutrons has been determined. The Cu cathode of a proportional counter was coated with electrolytically deposited U which was converted to U_3O_8 by heating. The exact amount of U was determined by accurate weighing. The fission counter and a Ra-Be neutron source were placed inside a large paraffin block. Operating the counter in the proportional region, large fission pulses were detected against a background of natural α-ray pulses, using the usual amplifier, discriminator, scaling, and recording circuits. In order to separate the effects of thermal neutrons, the observations were taken with and without a 1/2 mm Cd shield around the counter and the difference gave the rate of thermal neutron fissions, which were attributed to U^{235}. To measure the neutron flux a BF_3 counter of identical dimensions was placed in the same position in the paraffin block as the fission counter and the number of thermal neutrons were counted with the Cd-difference method. The cross-section of fission of (U^{235}) for thermal neutrons was determined as $(526 \pm 10) \times 10^{-24}$ cm^2.

1400 An accurate nuclear magnetic resonance method for measuring spin-lattice relaxation times. Erwin L. Hahn. *Phys. Rev. 76*, 145-6(1949) July 1 (Letter to the editor).

The bridge method, *Phys. Rev. 71*, 466(1947), for obtaining nuclear magnetic resonance has been applied in conjunction with an electronic technique, *Phys. Rev. 75*, 1326(1949), which permits accurate measurements of spin-lattice relaxation times T_1. The recovery in time of a non-equilibrium value of the energetic component of nuclear magnetization, $M_z(t)$, toward thermal equilibrium M_o is observed by measurement of resonance absorption and emission signal amplitudes on the oscilloscope which are proportional to $M_z(t)$. For protons in water, T_1 was obtained as 2.33 ± 0.07 sec as compared with 2.3 ± 0.5 sec measured by Purcell, et al., (*Phys. Rev. 71*, loc. cit.)

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1401 Anomalous magnetic moments of nucleons. S. D. Drell. *Phys. Rev.* 76, 427(1949) Aug. 1 (Letter to the editor).

Previous work, *Phys. Rev.* 76, 205(1949), has been extended to the calculation of the anomalous magnetic moments of nucleons. The interaction between quantized Dirac nucleon fields, quantized scalar and pseudoscalar meson fields, and an applied magnetic field is investigated by third-order perturbation theory. The results obtained are summarized for the charged, symmetric, and neutral meson theories. With proper adjustments in notation these results agree with those obtained by different means by Luttinger, *Helv. Phys. Acta* 21, 483 (1948), Slotnick, *Phys. Rev.* 75, 1295(1949), and Case, *Phys. Rev.* 74, 1884(1948); 76, 1(1949), for pseudoscalar theories, and by Case for a scalar meson field. The following numerical values are given for mesons of mass 300 m_e:

Charged meson theory	Scalar	Pseudoscalar
	$\mu_N = +.49(g^2/4\pi)$	$\mu_N = -.13(g^2/4\pi)$
	$\mu_P - 1 = -.30(g^2/4\pi)$	$\mu_P - 1 = +.054(g^2/4\pi)$
Symmetric meson theory		
	$\mu_N = +.98(g^2/4\pi)$	$\mu_N = -.26(g^2/4\pi)$
	$\mu_P - 1 = -.42(g^2/4\pi)$	$\mu_P - 1 = +.034(g^2/4\pi)$.

The results obtained are discussed.

1402 Computed binding energies of some light nuclei. J. Samuel Smart. *Phys. Rev.* 76, 439-40(1949) Aug. 1 (Letter to the editor).

The curve of the variation in binding energy with the atomic weight has been redetermined, *Phys. Rev.* 55, 691(1939), taking into account recent changes in accepted mass values. The curve obtained indicates that closed shells occur at masses 20 and 32. If jj-coupling is assumed and if it is assumed that the 2s level in nuclei lies below the 3d, then the theory predicts closed shells for 10 and 16 neutrons and protons, or for Ne^{20} and S^{32}. The calculated mass values are given for O^{19}, O^{20}, F^{22}, Na^{26}, Al^{30}, P^{34}, and Cl^{38}. These are compared with the experimental values in the case of O^{19}, P^{34}, and Cl^{38}.

1403 Determination of nuclear gyromagnetic ratios. I. John R. Zimmerman and Dudley Williams. *Phys. Rev.* 76, 350-7(1949) Aug. 1 (See also NSA 2-1231).

Nuclear magnetic resonance absorption peaks have been observed for 17 nuclear species. The technique used in observing the resonances involves the use of super-regenerative oscillators and is different in many respects from the bridge method of Purcell and the nuclear induction method of Bloch. Resonance absorption has been observed for the following nuclei: H^1, H^2, Li^7, Be^9, B^{11}, F^{19}, Na^{23}, Al^{27}, P^{31}, Cu^{63}, Cu^{65}, Br^{79}, Br^{81}, Rb^{85}, Rb^{87}, I^{127}, and Cs^{133}. By comparison of various resonance peaks with the proton resonance peak observed simultaneously in the same magnetic field, values for nuclear gyromagnetic ratios and nuclear magnetic moments can be determined in terms of the gyromagnetic ratio and the magnetic moment of the proton. The following frequency ratios have been obtained:

Nucleus	Ratio of resonance frequency to proton frequency in the same magnetic field
H^2	0.15355 ± 0.03%
Li^7	0.38862 ± 0.02
B^{11}	0.32076 ± 0.03
F^{19}	0.94086 ± 0.02
Na^{23}	0.26454 ± 0.03
Al^{27}	0.26062 ± 0.04
Cu^{63}	0.26515 ± 0.02
Cu^{65}	0.28404 ± 0.03
Br^{79}	0.25059 ± 0.02
Br^{81}	0.27014 ± 0.02
Rb^{87}	0.32718 ± 0.05
I^{127}	0.20003 ± 0.04

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1404 Hyperfine structure of Te^{125}. G. R. Fowles. *Phys. Rev.* 76, 571(1949) Aug. 15 (Letter to the editor).

Hyperfine structure in the spectrum of singly ionized Te^{125} has been observed with a Fabry-Perot etalon, using Te 80% enriched in that isotope. From the data obtained it is concluded that the spin of Te^{125} is 1/2.

1405 Long-lived tellurium isomers. R. D. Hill. *Phys. Rev.* 76, 333-5(1949) Aug. 1.

The internal conversion electron spectra of neutron-activated enriched Te isotopes have been studied. It has been shown that each odd mass-number isotope from 121 to 131 exists in a long-lived isomeric state. In all cases the initial isomeric transition is 2^4-pole magnetic, which appears to identify the long-lived isomeric states with a spin of 11/2. The spins of the ground states of Te^{127}, Te^{129}, Te^{131} would appear to be 3/2, and that of Te^{123} 1/2. The information about Te^{121} and Te^{125} ground states is incomplete.

1406 The magnetic moment of B^{11}. Donald A. Anderson. *Phys. Rev.* 76, 434(1949) Aug. 1 (Letter to the editor).

The gyromagnetic ratio of B^{11} has been compared with that of the proton by measuring the ratio of their Larmor precession frequencies in the same magnetic field. The ratio of the resonant frequencies is: $\frac{\nu_B}{\nu_P} = 0.320827 \pm 0.000004$. Making a small diamagnetic correction, assuming a spin of 3/2 and using the value 2.79352 ± 0.031% for the proton moment, the following value was obtained for the B^{11} moment: $\mu B = 2.68939$ (±0.031%) nuclear magnetons. Both resonances were observed in a supersaturated solution of K metaborate prepared by mixing 8 g of H_3BO_3 with a 10 cc boiling solution of 7 g of KOH. An absorption method with a simple regenerative circuit was used at 30 mc for the proton, and the induction method for the B. For the frequency determinations, reference was made to a stable crystal controlled standard. The induction apparatus, which was believed to provide optimum conditions for the necessary observations, is described in detail.

1407 Nuclear magnetic moments from microwave spectra: I^{127} and I^{129}. Walter Gordy, O. R. Gilliam, and Ralph Livingston. *Phys. Rev.* 76, 443-4(1949) Aug. 1 (Letter to the editor).

The effects of a magnetic field on the hyperfine structure of the J = 2→3 transition of CH_3I^{127} and CH_3I^{129} have been studied. The average value obtained from the data for $\mu(I^{127})$ was 2.792 nuclear magnetons with a mean deviation of 0.062 nuclear magnetons. For I^{129} the nuclear g-factor and the magnetic moment were determined as 0.783 and 2.74, respectively. The results obtained indicate that the orbital and spin vectors of the odd proton in the nucleus are opposed, I = l - 1/2. Thus, the nuclear orbital momentum, l, equals four. It is also noted that an anomaly was detected, which appears to result from a breaking down of the nuclear quadrupole coupling by the applied magnetic field, which is being studied further. The microwave method used is particularly suited to the study of rare or radioactive nuclei.

1408 The nuclear moments of P^{31}. M. F. Crawford and J. Levinson. *Can. J. Research* 27, 156-63(1949) July.

Hyperfine structures have been observed in the $3s4s\ ^3S_1 - 3s4p\ ^3P^o_{0,1,2}$ transitions of P IV with a 21 ft concave grating and in the $4s\ ^2S_{1/2} - 4p\ ^2P^o_{1/2}$ transition of P III with a transmission echelon. The half-widths of the lines, excited in an electrodeless discharge, were reduced by mixing Ne with the P vapor and by using a condenser of small capacity. Their intensities were increased by discharging the condenser through the exciting coil nine times per half-cycle by means of a rotating spark gap. The structures of the P IV lines confirm I = 1/2 and show that μ, the nuclear magnetic moment, is positive; $\mu = 1.15 \pm 0.05$ n.m. and $\mu = 1.11 \pm 0.1$ n.m. are obtained from the P IV and P III structures, respectively.

1409 The nuclear spin and magnetic moment of Cs^{137}. Luther Davis, Jr. *Phys. Rev.* 76, 435-6(1949) Aug. 1 (Letter to the editor).

The atomic beam magnetic resonance method, *Phys. Rev.* 57, 765(1940), as used by Zacharias, *Phys. Rev.* 61, 967(1942), to determine the nuclear spin and magnetic moment of K^{40} has been used to determine the nuclear spin and magnetic moment of Cs^{137}. The results obtained lead to the assignment of a spin of 7/2 to this nucleus and a nuclear magnetic moment of 2.837 ± 0.010 nuclear magnetons.

PHYSICS (continued)

1410 Quadrupole moment of Sb^{121} and Sb^{123}. K. Murakawa and S. Suwa. *Phys. Rev. 76*, 433-4(1949) Aug. 1 (Letter to the editor).

In order to find the values of the quadrupole moments of Sb^{121} and Sb^{123}, the hyperfine structure of the spectrum of Sb II was studied. This was excited in an Al hollow cathode discharge tube which was filled with Ne of a few mm Hg pressure. The cathode contained some powdered Sb and was cooled with water. The fine structure was examined by the use of two glass Lummer plates, a quartz Lummer plate, and a Fabry-Pérot etalon by means of Casimir's formula, *Verhandel. Teylers Tweede Genootschap., Haarlem* 11(1936), the quadrupole moments have been determined to be: 1) $Q^{121} = (-0.3 \pm 0.2) \times 10^{-24}$ cm^2 and 2) $Q^{123} = (-1.2 \pm 0.2) \times 10^{-24}$ cm^2.

1411 The atomic rocket. I. L. R. Shepherd and A. V. Cleaver. *J. Brit. Interplanetary Soc. 7*, 185-94(1948) Sept.

The problems of rocket propulsion and some of the limitations of chemical fuels for interplanetary travel are noted. The latter lead to a consideration of the possible applications of nuclear energy for this purpose, i.e., to supply heat to a working fluid which is then ejected at a high velocity. Some of the difficulties which include radiation hazards are discussed.

1412 The atomic rocket. II. L. R. Shepard and A. V. Cleaver. *J. Brit. Interplanetary Soc. 7*, 234-41(1948) Nov.

On the basis of the results obtained for the expansion of an ideal gas through a rocket nozzle, the choice of a suitable rocket propellant fluid is considered. Performance is largely controlled by the maximum temperature θ to which the propellant can be heated. For a given θ, the highest exhaust velocity would be obtained with the propellant having the lowest molecular weight M at this temperature. Dissociation is shown to be beneficial both in lowering M and in increasing the heat capacity of the propellant. It is noted that although H would give an exhaust velocity exceeding that of any other possible propellant it possess poor storage properties in the liquid state. As an example of an alternative propellant, NH_3, which dissociates at temperatures as low as 1,000°K, is suggested. Mean molecular weights and heat capacities are quoted for H and NH_3 at 50 atm pressure, in the range 3,000°K -5,000°K. Exhaust velocities of 5 - 15 km/sec are considered possible.

1413 The atomic rocket. III. L. R. Shepherd and A. V. Cleaver. *J. Brit. Interplanetary Soc. 8*, 23-7(1949) Jan.

The use of nuclear energy to heat the propellant fluid of a rocket would give rise to several problems. These are discussed and the following possibilities are considered: (1) The solid reactor, in which the propellant is pumped through suitable channels in a nuclear reactor, receiving energy by surface heat transfer, and (2) the gaseous reactor, in which propellant and nuclear fuel are mixed in a gaseous state under such conditions of temperature, pressure and fuel concentration that a chain reaction occurs. The possible sizes of fast and thermal neutron systems are estimated from the available data for case (1). It is noted that although the masses of unshielded reactors are not excessive, the limitation set on maximum propellant temperature by the melting points of reactor materials is a serious draw back, as is the problem of the power required to pump the propellant through the reactor. These difficulties would be eliminated in the gaseous reactor. The conditions for sustaining a reaction in gaseous mixtures of U^{235} with H and U^{235} with D are considered. In both cases the conditions for a chain reaction appear impossible, calling for prohibitive chamber pressures or dimensions.

1414 The atomic rocket. IV. L. R. Shepherd and A. V. Cleaver. *J. Brit. Interplanetary Soc. 8*, 59-70(1949) Mar.

The problem of excessive power dissipation which would be expected in rockets powered by nuclear reactions is considered. For vehicles moving in free space it would be permissible to use very low propulsive thrusts and very high exhaust velocities ($\geq$ 100 km/sec) might then be employed. The most probable method of obtaining the desired exhaust velocities would be the acceleration of ions in electrostatic fields. A quantitative discussion indicates that heavy ions and comparatively high accelerating voltages would be preferable in order to limit the ion currents. Ions of both signs would have to be ejected to maintain electrical neutrality and waste heat would have to be discarded by radiation. The conversion of energy released in the nuclear reactor into electrical energy for accelerating the ions would prove a major problem as existing generation techniques would be completely inadequate. A possible solution might lie in direct conversion of nuclear into electrical energy.

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1415 Spallation products of arsenic with 190-Mev deuterons. H. H. Hopkins, Jr. AECU-393, July 7, 1949. 4p. (Suppl. to AECU-212; See also NSA 2-2149).

Recent investigations of the nuclei formed when As is bombarded with 190-Mev deuterons in the 184-inch cyclotron have been extended, H. H Hopkins, Jr. and B. B. Cunningham, *Phys. Rev. 73*, 1406(1948). The use of improved chemical separations and counting techniques has enabled identification of 38 nuclear species among the elements from Cr through Se. Lists of the isotopes identified, the observed and literature half-lives, G. T. Seaborg and I. Perlman, *Revs. Mod. Phys. 20*, 585(1948), and the yields relative to that of As^{72} are presented. Assuming that stable nuclei are formed in the spallation process with yields not far different from those of the adjacent isotopes, a yield is assigned to each isotope not observed following the trends apparent among the observed isotopes. The resultant yield pattern is as follows: (1) For each element below As, the yields of the isotopes increase toward the line of nuclear stability. (2) For each mass number the yields of isobars increase toward the line of stability. (3) The lower the atomic number, the lower becomes the total yield of a given element.

From a consideration of the Q values of the reactions and the energy necessary for coulombic barrier penetrations, it is concluded: (1) Reactions leading to As, Ge, and Ga isotopes are mostly non-capture excitation reactions, in which only a fraction of the deuteron's energy is imparted to the nucleus. These comprise > 90% of all the reactions. (2) Less likely processes involving preliminary capture of the deuteron lead to isotopes of lower lying elements. (3) The formation of nuclear species lower than Fe^{57} involves the emission of one or more α-particles. Such reactions occur ~ 1% of the time. This document is a supplement to AECU-212.

1416 The emission of short-range alpha particles from light elements under proton bombardment. I. Experimental method and the reaction $^{10}B(p\alpha)^{7}Be$. W. E. Burcham and Joan M. Freeman. *Phil. Mag. 40*, 807-30(1949) Aug.

A method for studying the emission of short-range α particles in the bombardment of light nuclei by protons is described. The α particles have been resolved from the scattered protons by a 90° focusing magnet and detected by a fluorescent screen and photoelectric multiplier. The results of an investigation of the $B^{10}(p\alpha)$ reaction by this method are presented. The Q-value of the reaction has been found to be 1.11 Mev ± 0.06, and the cross-section to be 1.2×10^{-26} cm^2 at a proton energy of 530 Kev. A target of separated B^{10} isotope was used. 38 references. 11 figures.

1417 Energy release in beryllium and lithium reactions with protons. A. V. Tollestrup, W. A. Fowler, and C. C. Lauritsen. *Phys. Rev. 76*, 428-30(1949) Aug. 1 (Letter to the editor).

Measurements have been made on the energy released in the reactions: (1) $Be^{9}+H^{1}\rightarrow Li^{6}+He^{4}+Q_1$, (2a) $Be^{9}+H^{1}\rightarrow Be^{8}+D^{2}+Q_2$, (2b) $Be^{8}\rightarrow 2He^{4}+Q_2'$, and (3) $Li^{6}+H^{1}\rightarrow He^{3}+He^{4}+Q_3$. Protons monoenergetic to better than 0.03% were obtained from an electrostatic accelerator and analyzer previously described, *Rev. Sci. Inst. 18*, 818(1947). The targets used in studying reactions (1) and (2) were Be foils which were 10-20 kev thick for fast protons. The target for reaction (3) was produced by evaporating a thin Li layer on Cu in a vacuum. The energy of the ions produced in the reactions was accurately determined by a double-focusing magnetic spectrograph, *Phys. Rev. 74*, 1564(A)(1948). A scintillation counter was used to detect the particles and the introduction of thin Al foils of known stopping power in front of the ZnS screen made it possible to separate ions of different charge and energy. The curves obtained, which were used to calculate the Q-values, are shown. It was found that Q_1 = 2.121 ± 0.012 Mev, Q_2 = 0.558 ± 0.003 Mev, Q_3 = 4.017 ± 0.022, and Q_2' = 89 ± 5 kev. A combination of the above Q-values with those of $D(dp)H^3$ and $D(dn)He^3$, which have Q-values of 4.036 ± 0.022 Mev and 3.265 ± 0.018 Mev, respectively, Tollestrup, et. al., *Phys. Rev. 75*, 1947(1949), and the binding energy of the deuteron, 2.237 ± 0.007 Mev, Bell and Elliott, *Phys. Rev. 74*, 1552(1948), makes it possible to calculate the energy release in the reactions $Li^{6}(nH^{3})He^{4}$ and $Be^{9}(\gamma n)Be^{8}$. For the first reaction Q = 4.788 ± 0.023 Mev and for the second, Q = -1.679 ± 0.008 Mev.

1418 Excitation functions for (α,n), (α,2n), and (α,3n) reactions on indium. Georges M. Temmer. *Phys. Rev. 76*, 424-6(1949) Aug. 1.

The bombardment of In (isotopic abundance of 95.5% In^{115}) with 37-Mev α-particles from the Berkeley 60-inch cyclotron produced sufficient excitation in the compound nucleus for the evaporation of one, two, and three neutrons. Hence activities in the (α,n), (α,2n), and (α,3n) products were found and identified chemically as Sb. By means of calutron analyses the mass numbers 116, 117, and 118 were assigned. The periods found for Sb^{118} and Sb^{117} (5.1 hr and 2.8 hr) agree with those

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reported by Coleman and Pool, *Phys. Rev.* 72, 1070(1947). Sb^{116} decays with a 60-min half-life. These three periods are too close together to permit their satisfactory resolution from composite decay curves for the establishment of excitation curves. In order to separate the periods more effectively, use was made of a magnetic lens β-ray spectrometer of the Siegbahn type, *Phil. Mag.* 37, 162(1946). The curves for the β-spectra are shown. The data obtained indicated the conversion of a 156-kev γ-ray in the K-shell from the decay of Sb^{117}. In addition a conversion peak was obtained which corresponded to a 260-kev γ-ray decaying with the half-life of Sb^{118}. By means of an electron-positron discriminator (helical baffle), it was found that no continuous β-spectrum is present, as is to be expected for neutron-deficient isotopes. Hence the two other isotopes (Sb^{118} and Sb^{117}) must decay primarily by K-capture. Curves of the excitation functions are shown which were obtained using the stacked-foil technique with steps of about 1 Mev in α-particle energy and a rotating assembly permitting rapid measurements. The data are compared with the theoretical capture cross section values calculated by Weisskopf (MDDC 1175, p. 105 (Los Alamos Notes). It is noted that general agreement is obtained over the portion of the (α,n) curve up to the point of inflection at about 16 Mev where the competition of the $(\alpha,2n)$ process sets in. Because of the unknown ratio of these two processes, it is not possible to add the two contributions constituting the modes of decay of the compound nucleus. The $(\alpha,2n)$ mode is brought down in turn by the $(\alpha,3n)$ process, beginning at about 26 Mev and still rising at the highest energy investigated.

1419 Gamma-radiation from deuteron bombardment of Be^9. V. K. Rasmussen, W. F. Hornyak, and T. Lauritsen. *Phys. Rev.* 76, 581-2(1949) Aug. 15 (Letter to the editor).

Further measurements of the γ radiations which occur following the deuteron bombardment of Be^9 are reported. As in the previously reported work of Lauritsen, et. al., *Phys. Rev.* 73, 636 (1948), 74, 1566A(1948), and 75, 199(1949), the γ-ray energies have been determined from the photo-electrons produced in Th converters, using a magnetic lens spectrograph. A vacuum connection to an electrostatic accelerator permits deuteron bombardment of targets within the spectrometer. The results of a number of runs, using a thick target with a deuteron energy of 1.2 Mev, are tabulated.

Nucleus	E_γ	I_γ	I_n	$E_{transition}$	n x 713
B^{10*}	413.5 ± 1	14	53	412 ± 1.5	
B^{10*}	716.6 ± 1	56		713 ± 1.5	713
B^{10*}	1021.6 ± 2	13		(1016 ± 2)	
B^{10*}	1432.9 ± 5	8.7		1424 ± 5	1426
B^{10*}	2152.0 ± 15	2.9	22	2138 ± 15	2139
B^{10*}	2871.0 ± 15	4.6		(2853 ± 15)	2852
B^{10*}	3604.0 ± 30	1.5	25	3580 ± 30	3565
Li^{7*}	(427)	15		(476.6 ± 0.8)	
Be^{10*}	3380 ± 15	6.2		3359 ± 15	

It is noted that a number of the transition energies are integral multiples of 713 kev to an accuracy of the order of 0.5%.

1420 Long-range protons from the He^3 (d,p) α-reaction. J. Hatton and G. Preston. *Nature* 164, 143-4(1949) July 23 (letter to the editor).

Measurements of the energies of the protons emitted in the reaction $He^3 + D^2 = He^4 + H^1$ have been made to determine whether the α-particle has any excited states below 18.3 Mev; if the α-particle could be left in excited states the emitted protons would have a number of discrete energy values. A heavy-ice target was bombarded with He^3 using a Cockroft-Walton type accelerator. The He^3 ions were produced in an r-f excited ion source supplied with helium in which the He^3 content had been enriched to about 4×10^{-3} by means of thermal diffusion. A thin-windowed Al proportional counter was used and the proton energies were determined by means of Al foil absorption measurements. Two groups of protons were found which had ranges of approximately 325 mg/cm^2 (14.6 Mev) and 21 mg/cm^2 (2.9 Mev). The latter group was identified as the product of a background D-D reaction. The results indicate that in the reaction under consideration there are no low-energy proton groups with an intensity as high as 1% of the main group having energies greater than 2.9 Mev. Using He^3 ions accelerated to an energy of 160 kev, the cross section for the reaction $He^3 + D^2 = He^4 + H^1$ was estimated to be of the order of one-tenth of that for the D-D reaction at the same bombarding energy. From a curve of the

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proton yield as a function of bombarding energy, it was determined that at an energy of 1 Mev, approximately 10^7 long-range protons per minute per μamp of He^3 ions incident on a heavy-ice target would be produced over a solid angle of 4π.

1421 Photo-disintegration of deuterium by seven- to twenty-Mev x-rays. Everett G. Fuller. *Phys. Rev. 76*, 576-7(1949) Aug. 15 (Letter to the editor).

A preliminary study has been made of the angular distributions and distribution in energy of the protons arising from the photo-disintegration of deuterium by the continuous x-ray spectrum from 20.8-Mev electrons in the betatron. The relative cross section for the reaction, as a function of quantum energy determined from the data, is shown and compared with some of the theoretical points. The angular distributions of the photo-protons in the ranges 8.0-9.9, 10.0-13.9, and 14.0-20.3 Mev are shown. The amount of the asymmetry observed is of the order of magnitude of that given by the theory of Rose and Goertzel, *Phys. Rev. 72*, 749(1947).

1422 The photo-disintegration of oxygen into four alpha particles. F. K. Goward, E. W. Titterton, and J. J. Wilkins. *Proc. Phys. Soc. (London) 62 A*, 460(1949) July 1 (Letter to the editor).

The Harwell synchrotron has been used to irradiate unloaded Ilford plates with a continuous spectrum of γ-rays extending to 23 Mev. Many "stars" were observed, consisting of three or four charged particles, in some of which unobserved neutrons may have been present. Among the stars observed, thirteen have consisted of four α-particles and may be identified as disintegrating O. The cross section of the reaction by which the O disintegrates has been estimated (for quanta between 20.5 and 23 Mev) as 2×10^{-29} cm^2.

1423 Relative yields of the D-D reactions at low energies. T. P. Pepper. *Can. J. Research 27*, 143-50(1949) July.

By the simultaneous detection of the H^1, H^3, and He^3 particles in a thin window proportional counter the concurrent nuclear reactions $H^2(d,p)H^3$ and $H^2(d,n)He^3$ have been investigated throughout the deuteron energy range 26 to 63 kev. The ratio of the yield of the reaction $H^2(d,n)He^3$ was found to be 1.15 ± 0.15 throughout this energy range. There is some slight evidence for an increase in this ratio toward lower bombarding energies.

1424 Electron gun emission and x-ray output for three betatrons. W. F. Westendorp and F. R. Elder. *Phys. Rev. 76*, 445(1949) Aug. 1 (Letter to the editor).

Measurements of the x-ray output as a function of the electron gun emission were made on 10, 50 and 100-Mev betatrons. The curves for the different machines differ widely and it is interesting to note the change in the shape of the curves with the gun voltage. For the greater portion of the curves the x-ray output shows a greater than linear variation with the gun electron emission. For all three machines the maximum x-ray output obtainable with excess emission available at a given gun voltage varies as about the 1.25 power of the gun voltage.

1425 An error in a paper by Landau on Coulomb interactions in a plasma. William P. Allis. *Phys. Rev. 76*, 146(1949) July 1 (Letter to the editor).

The author applies a correction to the result obtained by Landau, *Physik Z. Sowjetunion 10*, 154(1936), in his attempt to show that the Coulomb interactions of electrons and ions in a plasma can be represented as the divergence of a flow vector in momentum space. Taking into account the singularity of "w" at zero deflection, which Landau neglected to do, the equation obtained by Landau (p. 156) remains unchanged except for the sign before the second parenthesis. Another correction, the necessity for integrating at constant scattering angle, is also noted.

1426 Guide to literature of elementary particle physics, including cosmic rays. J. Tiomno and John A. Wheeler. *Am. Scientist 37*, 417-20(1949) July. (See also NSA 2-2002).

This bibliography is concluded from a previous issue, *37*, 202-18(1949) April.

1427 Proceedings of the American Physical Society. Minutes of the semi-centennial meeting at Cambridge, June 16-18, 1949. *Phys. Rev. 76*, 451-75(1949) Aug. 1.

The 293rd meeting of the American Physical Society was held on Thursday, Friday, and Saturday, June 16, 17, and 18, 1949, in the buildings of Harvard University and the Massachusetts Institute of Technology in Cambridge, Massachusetts. Included in the invited papers were the following: Quantum electrodynamics, Julian Schwinger; The sun and cosmic rays, M. S. Vallarta. The papers for which abstracts are given include the following: Radioactive materials as x-ray

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sources, H. F. Gunlock; The effect of C^{14}, Ca^{45}, P^{32}, I^{131}, and Zn^{65} on photographic emulsions, Daniel Steinberg and A. K. Solomon; On the excited states of Li^{17}, Michel Ter-Pogossian, J. Eugene Robinson, and Harold Goddard; K capture of Be^{7} and the excited state of Li^{7}, R. M. Williamson and H. T. Richards; Disintegration energy of Al^{29}, L. Seidlitz, E. Bleuler, and D. J. Tendam; The forbidden beta-spectra of Sr^{89}, Sr^{90}, and Y^{90}, F. B. Shull, C. H. Braden, and L. Slack; The forbidden beta-spectra of Sr^{89} and Y^{90}, H. Clay Price, Jr. and Lawrence M. Langer; The beta-spectrum of silver-110, Werner S. Emmerich and J. D. Kurbatov; Radioactive tin 111, R. A. Hinshaw; Radiations from Indium (114) and Barium (140), C. E. Mandeville and E. Shapiro; Studies on synthetic LiF as a scintillation detector of heavy particles and quanta, E. C. Farmer, H. B. Moore, and Clark Goodman; Ring focus in a thin magnetic lens beta-ray spectrometer, Joseph M. Keller, Ernest Koenigsberg, and Arthur Paskin; Constant sensitivity gamma-ray detector. J. Pine and R. Sherr; A micro calorimeter suitable for study of easily absorbed nuclear radiations, C. V. Cannon and G. H. Jenks; Collimation error in small angle x-ray scattering, K. L. Yudowitch; Design of small, self-quenching, G-M Counters, C. V. Robinson; Effect of x-rays on the absorption and luminescence of alkali halide phosphors, James H. Schulman, Robert J. Ginther, Clifford C. Klick, and Lyle W. Evans; The helium wave equation, James H. Bartlett; A field formalism without self-action, T. A. Welton; Internal coordinates of a particle, H. C. Corben; The spin dependence of nuclear forces, Alex E. S. Green; Internal pair formation, M. E. Rose; Position theory, Frederik J. Belinfante; Capture of μ-mesons by deuterons, Irving Stein and L. I. Schiff; On the vector meson-photon interaction, George J. Yevick; Nutation of the nuclear magnetic moment, Erwin L. Hahn; Nuclear gyromagnetic ratios, William H. Chambers and Dudley Williams; Proton-proton scattering experiment at 250 Mev, Charles L. Oxley; Self-absorption and backscattering of soft beta-radiations, L. E. Glendenin and A. K. Solomon; The lifetime of positrons in matter, James W. Shearer and Martin Deutsch; Multiply scattered γ-rays: angular distribution, L. V. Spencer and Fannie Jenkins; A search for some rare stable isotopes, Henry E. Duckworth, Robert F. Black and Richard F. Woodcock; Nuclear energy levels in N^{15} and N^{16}, L. D. Wyly; The reactions $N^{14}(n,p)C^{14}$ and $He^{3}(n,p)H^{3}$ and the neutron-hydrogen mass difference, W. Franzen, J. Halpern, and W. E. Stephens; Neutron distributions in cylindrical geometry, Henry Faul and Clark Goodman; Determination of the phase of scattering of neutrons and of incohernet residual scattering cross sections, P. J. Bendt and I. W. Ruderman; Reflection of neutrons from magnetized mirrors, D. J. Hughes and M. T. Burgy; Neutron spectra from (p,n) reactions with 16-Mev protons, P. C. Gugelot and M. G. White; Evidence for broad nuclear energy levels in lead, R. K. Adair, H. H. Barschall, C. K. Bockelman, R. L. Henkel, and R. E. Peterson; Fast neutrons from bombardment with the cyclotron particles, A. J. Allen, J. F. Nechaj; K. H. Sun, and B. Jennings; Neutron spectrum from $N^{15}(d,n)$, Emmett L. Hudspeth and Charles P. Swann; Isotopic spectra of lead, Thurston E. Manning; Solar position calculator, Donald W. Dunipace; Presentation of mass spectra with a cathode-ray oscillograph, J. W. Townsend, Jr.; Some measurements of nuclear spin-lattice relaxation times in solids, E. H.Turner, A. M. Sachs, and E. M. Purcell; A study of internal motion in annomium salts by nuclear spin-lattice relaxation time measurements, A. M. Sachs, E. H. Turner, and E. M. Purcell; Measurements of spin-lattice relaxation time in paramagnetic solids by the saturation method, C. P. Slichter and E. M. Purcell; Hyperfine structure of the paramagnetic resonance spectrum of cobalt, B. Bleaney and D. J. E. Ingram; The solids condensed from carbon monoxide by alpha particles, John H. L. Watson, Marcel Vanpee, and S. C. Lind; Cosmic-ray variations at high altitudes resulting from meteorological variations, W. F. G. Swann and Stephen H. Forbes; Penetrating power of extensive shower particles, L. D. White, G. G. Harris, and George T. Reynolds; The positive excess in the mesotron spectrum, Robert B. Brode; Examples of meson production and absorption, R. L. Cool, E. C. Fowler, and J. C. Street; Spontaneous decay rate of heavy mesons, L. I. Schiff; High energy events at high altitude, J. Hornbostel and E. O. Salant; Measurements and interpretation on the "showers associated with stars in nuclear emulsions, L. S. Osborne and B. T. Feld; Energy degeneration of cosmic-ray primaries, F. J. Milford and L. L. Foldy; Rotating illumination method of locating stars in nuclear track plates, E. H. Land and W. A. Shurcliff; Background eradiacation of thick-layered nuclear emulsions, M. Wiener and H. Yagoda; The radiofrequency spectrum of $Rb^{85}F$ and

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$Rb^{87}F$, Vernon Hughes, Ludwig Grabner, and I. I. Rabi; Isotopic frequencies in the microwave spectra of OCS and CH_3Cl, D. Bianco, G. Matlack, and A. Roberts; Quadrupole interactions in pressure broadening of ammonia inversion spectrum by non-polar gases, William V. Smith and Raydeen Howard; An experimental limit for the inequality of the electron and proton charges, Vernon Hughes; A theoretical treatment of neutron attenuation in thick shields, S. W. W. Shor.

1428 **Proceedings of the American Physical Society.** *Phys. Rev. 76*, 195-203(1949) July 1.

Among the invited papers presented at the fifteenth annual meeting of the Southeastern Section of the American Physical Society, held at Clemson College, Clemson, South Carolina, on Friday and Saturday, April 15-16, 1949, were the following: Search for beta-proton coincidences associated with neutron decay, A. H. Snell; The Oak Ridge National Laboratory, A. M. Weinberg. Abstracts of the following papers, which were also among those presented, are included: Neutron-induced short-life activities, Edward C. Campbell and Wilfred M. Good; Electron-neutrino correlation in heavy elements, M. E. Rose; Some isotopic neutron absorption cross sections, H. S. Pomerance; Neutron diffraction studies of AgCl, $Ag^{107}Cl$, and $Ag^{109}Cl$, W. A. Strauser, C. G. Shull, and E. O. Wollan; An experiment in x-ray scattering, Eric Rodgers; Color produced in quartz by x-rays, Guy Forman; Photo-multiplier detector for x-ray spectrometer, J. S. Brown, G. M. Farrior, and Arthur Waltner; On the knock-on secondaries of penetrating particles, E. D. Palmatier, W. W. Brown, and A. S. McKay; Optimum thickness for alpha-particles of phosphor surface in scintillation counter, J. M. Watkins, Jr. and A. C. Menius, Jr.; An improved scintillation counter, Arthur Waltner; Three-fold coincidence counter, W. H. Jordan and J. C. Gundlach; On the rate of energy loss of protons and deuterons, W. A. Bowers; Composite particles, H. M. Moseley; A portable vacuum tube electrometer of wide utility, E. E. Bortner; Apparatus for the study of the Philips gage discharge, Talbot Chubb; On the beta-spectrum of tritium, W. J. Byatt, F. T. Rogers, and A. W. Waltner.

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1429 Proceedings of the American Physical Society---minutes of the meeting at Washington, April 28-30, 1949. *Phys. Rev.* 76, 160-194(1949) July 1.

Among the papers presented at the 1949 Spring Meeting of the American Physical Society, 292nd of the series, held at Washington, D. C., on Thursday, Friday, and Saturday, April 28, 29, and 30, 1949, were the following: Scattering of neutrons and protons and the range of nuclear forces, H. A. Bethe: Proton-proton scattering, R. G. Herb; Scattering of protons by helium-4, C. L. Critchfield; Interpretation of recent experiments with protons on lithium, R. F. Christy; Gamma-ray spectroscopy, Thomas Lauritsen; Recent results with the slow-neutron spectrometer at Columbia University, L. J. Rainwater; Recent progress in the understanding of beta-ray disintegration, E. P. Wigner; Radioactivity of carbon-10 and oxygen-14. M. G. White, Rubby Sherr, and Herbert Muether; A survey of energy-levels of radioactive nuclei, A. C. G. Mitchell; Deep energy levels in nuclei from neon to calcium, E. C. Pollard; Astronomical, radioactive, and atomic time, George Gamow; Recent experimental work at the Berkeley Radiation Laboratory, L. W. Alvarez; Recent developments in the quantum theory of fields, F. J. Dyson; Progress in the study of nuclear magnetic resonance since the 1949 symposium at Washington, E. M. Purcell; Interpretation of high-energy experiments at the Berkeley Radiation Laboratory, Robert Serber. Abstracts are included of the following papers which were also presented: The design and construction of the Cornell synchrotron, Boyce D. McDaniel, John W. DeWire, Dale R. Corson, and Robert R. Wilson; Initial performance of the Cornell synchrotron, D. R. Corson, C. P. Baker, J. W. DeWire, B. D. McDaniel, C. D. Swartz, R. L. Walker, R. R. Wilson, and W. M. Woodward; Magnetic measurements on the M.I.T. 300-Mev electron synchrotron, J. S. Clark, W. W. Drake, and C. Y. Tsao; Shielding material for high energy accelerators, E. Creutz; Ceramic materials for synchrotron vacuum tubes, J. E. Thomas, Jr., W. M. Shakespeare, Jr., B. Cohen, R. B. Patten and V. P. Henri; Fast electron tracks in nuclear emulsions, W. Van der Grinten; Automatic grain counting of tracks in nuclear emulsions, P. V. C. Hough; Corrections to the range-energy curves for alpha-particles and protons, William P. Jesse and John Sadauskis; Further data on the spin gyromagnetic ratio of the electron, A. K. Mann and P. Kusch; Amplitude bridge for nuclear resonance detection, R. D. Huntoon and H. A. Thomas; Nuclear gyromagnetic ratios, John R. Zimmerman and Dudley Williams; Laboratory coincidence, anti-coincidence unit, C. A. Schroeder, J. D. Shipman, Jr., and P. R. McCray; A test set for measurement of dead time and recovery time of counters, K. Sitte; Search for systematic variations in cosmic-ray intensity predicted on the basis of a permanent solar magnetic moment, S. E. Forbush and I. Lange; Correlation of cosmic-ray geomagnetic effects, H. V. Neher; A search for cosmic-ray diurnal effects at rocket altitudes, G. J. Perlow, C. W. Kissinger, and C. A. Schroeder; Gamma-rays in the primary cosmic radiation, C. W. Kissinger, C. A. Schroeder, and G. J. Perlow; Further results in the search for electrons in the primary cosmic radiation, Robert I. Hulsizer; Momentum spectra and positive excess of cosmic ray particles at 11,000 feet, Charles E. Miller, Joseph E. Henderson, D. S. Potter, Jay Todd, Jr., and A. W. Wotring; On the neutrons in the atmosphere, J. A. Simpson, Jr., H. W. Baldwin, and R. B. Uretz; Distribution of slow neutrons in free atmosphere up to 102,000 feet, Luke C. L Yuan; The properties of cosmic radiation in the lower atmosphere, Martin A. Pomerantz; Soft x-radiation in the upper atmosphere, T.R. Burnight; Observations at high altitudes of extreme ultraviolet and x-rays from the sun, J. D. Purcell, R. Tousey, and K. Watanabe; Angular distribution of protons from the D-D reaction for 10-Mev deuterons, H. A. Leiter, R. E. Meagher, F. A. Rodgers, and P. Gerald Kruger; Differential cross sections for the reaction $T^3(p,n)He^3$ from 1 to 2.5-Mev proton energies, G. A. Jarvis, A. Hemmendinger, H. V. Argo, and R. F. Taschek; Use of photographic plate detectors in experiments with 10-Mev deuterons, J. H. Williams, F. K. Tallmadge, and L. Rosen; Angular correlations in successive α-γ emission and the excited state of Li^7, Bernard T. Feld; Lifetime of the 479-kev excited state of Li^7, L. G. Elliott and R. E. Bell; Angular yield of protons, tritons, and alphas from the bombardment of Be^9 by deuterons, I. Resnick and S. S. Hanna; Excited state in Be^{10}, W. W. Buechner and E. N. Strait; Bombardment of B^{10} with deuterons, Charles P. Swann and Emmett L. Hudspeth; A study of the long range protons from the bombardment of carbon by deuterons, G. C. Phillips, T. W. Bonner, and J. E. Richardson; Highly excited states of the magnesium nucleus created by proton bombardment, Roy Britten; Q-values for $Ca^{40}(d,p)Ca^{41}$ and the mass difference (Ca^{40} - A^{40}), Vance L. Sailor; The $Cu^{63}(n,2n)Cu^{62}$ cross section as a function of neutron energy near the threshold, J. L. Fowler and J. M. Slye; Uniformity of response of a scintillation counter, F. B. Harrison and George T. Reynolds; Measurements of meson decay by scintillation counters, George T. Reynolds and F. B. Harrison; Interactions of ionizing cosmic-ray particles at 10,600 ft altitude, John Tinlot and Bernard Gregory; Further

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experiments on sea-level mesons stopped at thin Pb foils, W. Y. Chang; The production of mesons in the stratosphere, Marcel Schein and J. J. Lord; Magnetic deflection of mesons in photographic plates, I. Barbour; "Off-scale" bursts under 26.7 cm lead at an altitude of 3,500 meters, Edward F. Fahy and Marcel Schein; The density effect for cosmic ray mesons, W. L. Whittemore and J. C. Street; The nature of the penetrating particles in extensive showers, Frank L. Hereford; Altitude and latitude dependence of nuclear disintegrations measured in photographic emulsions in the stratosphere, J. J. Lord, Marcel Schein, and M. Vidale; Variation of cosmic star production with altitude, Herman Yagoda, Nathan Kaplan, and C. H. Conner; Delayed proton-electron activity induced in aluminum by non-ionizing cosmic rays, E. C. Fowler, R. L. Cool, and J. C. Street; Determination of the energy distribution of bremsstrahlung from 19.5 Mev electrons, H. W. Koch, R. E. Carter, and C. S. Robinson; Absorption by aluminum between 100A and 300A, E. M. Pell and D. H. Tomboulian; On the position of L_1 absorption edge in aluminum, D. H. Tomboulian and E. M. Pell; Simultaneity in the Compton effect, R. Hofstadter and J. A. McIntyre; Electron screening, electron quantum numbers, and ionization potentials of atoms and ions, Wolfgang Finkelnburg; Hollow cathode tube design for spectroscopic hyperfine structure studies with small samples, O. H. Arroe and J. E. Mack; Hyperfine structure and isotope shift studies, especially of the nuclear spin of Se^{77}, J. E. Mack and O. H. Arroe; Isotope shift in the HeI spectrum, Thurston E. Manning; Electron-nuclear potential fields from hyperfine structure, A. L. Schawlow and M. F. Crawford; The source of highly forbidden lines in CdI, Fernand E. Deloume and John R. Holmes; Improved baffle system for helical focusing β-ray spectrometer, L. Feldman and C. S. Wu; Magnetic time-of-flight mass spectrometer, Paul I. Richards, Earl E. Hays, and S. A. Goudsmit; Deflection of electrons in an inhomogeneous electrostatic field, Jenny E. Rosenthal; A microwave linear accelerator for electron, D. Errett, J. MacKay, R. Pepper, F. Rieke, D. Roller, and L. Silber; The neutron-hydrogen mass difference, William E. Stephens; Neutron-proton mass difference from the D-D reactions, A. V. Tollestrup, F. A. Jenkins, W. A. Fowler, and C. C. Lauritsen; Integral ratios between nuclear masses and binding energies, Enos E. Witmer; On fission-asymmetry, G. C. Wick; On the tripartition of U^{235} nuclei by thermal neutrons, Louis Rosen and Alvin M. Hudson; Ternary fission in uranium, J. T. Dewan and K. W. Allen; Electron excitation of In^{115}, B. Waldman, W. C. Miller, and D. Gideon; Capture gamma-ray studies, H. E. Kubitschek and S. M. Dancoff; The capture γ-ray spectrum of cadmium, Bernard Hamermesh; Angular distribution and relative yields of gamma-n processes with bremsstrahlung, G. A. Price and D. W. Kerst; X-ray yield curves for $(\gamma,2n)$ and (γ,p) reactions, G. C. Baldwin; Observation of 20-Mev gamma-rays from the $T^3(p,\gamma)He^4$ reaction, H. V. Argo, H. T. Gittings, A. Hemmendinger, G. A. Jarvis, H. Mayer, and R. F. Taschek; Radioactive sources of high specific activity produced with a betatron, R. A. Becker and F. S. Kirn; Low emission probability gamma-rays, R. G. Fluharty and Martin Deutsch; Instrumental errors in the shape of beta-spectra, C. Sharp Cook and George E. Owen; End-point of the tritium beta-ray spectrum, E. R. Graves and D. I. Meyer; The beta-spectrum of Be^{10}, P. R. Bell and J. M. Cassidy; Nitrogen 12, Luis W. Alvarez; Recoils from the beta-decay of Y^{90}, C. W. Sherwin; New radioactive isotopes of Yttrium and Zirconium, W. E. Scott, B. E. Robertson, and M. L. Pool; Columbium 90, 96 and molybdenum 91, 93, D. N. Kundu and M. L. Pool; Silver and cadmium activities, Jane R. Gum, Lowell E. Thompson, and M. L. Pool; Nuclear lifetime for a quadrupole transition in Cd^{111}, Martin Deutsch and Donald T. Stevenson; Relativity corrections for energy levels, V. Rojansky and Frank Stern; The K-shell internal conversion coefficients, M. E. Rose, G. H. Goertzel, B. I. Spinrad, J. Harr, and P. Strong; Note on wave functions in a magnetic field, M. H. Johnson and B. A. Lippman; Bremsstrahlung in heavy elements, H. Wergeland; ThC-C'' alpha-transition according to the water drop model of alpha-decay, J. E. Garvey and B. T. Darling; Closed shells in nuclei, Maria G. Mayer; The phenomenological theory of nuclear forces, Herman Feshbach; Relativistic generalization of phenomenological n-p interactions, Armand Siegel; Distributions from resonance reactions and angular correlation experiments, L. Eisenbud; Applications of the dispersion formula for nuclear reactions, T. Teichmann and E. P. Wigner; On the continuity of the first derivative in the Wigner-Eisenbud formalism, J. L. Jackson; Radioactive In and Sn, E. C. Mallary and M. L. Pool; Internal conversion electrons from long-lived tellurium isomers, R. D. Hill; Radiations from the 11-day neodymium and the 47-hour element 61, C. E. Mandeville and M. V. Scherb; Disintegration of Cs^{137}, Charles L. Peacock; Shapes of forbidden beta-spectra, Lawrence M. Langer and H. Clay Price, Jr.; The beta-spectrum of Tm^{170}, D. Saxon and J. Richards; Nuclear isomers produced by slow neutron capture, E. der Mateosian and M. Goldhaber; Transition energies of some nuclear isomers, R. L. Caldwell, E. der Mateosian, and M. Goldhaber; The radiations of Re^{186} and Re^{188}, Louis A. Beach, Charles L. Peacock, and Roger G. Wilkinson; Conversion electrons of RaD, L. Cranberg and

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J. Halpern; Correlation between direction and polarization of successive gamma-ray quanta, Franz Metzger and Martin Deutsch; Production of very high energy photons by 350-Mev protons, Herbert F. York, Burton J. Moyer, and Russell Bjorklund; A rotating-shutter time-of-flight neutron spectrometer for the resonance region, W. Selove; Neutron transmission and polarization measurements with an iron single crystal, Merle Burgy, D. J. Hughes, and W. E. Woolf; Neutron yield from 15-Mev deuterons, A. J. Allen, J. F. Nechaj, K. H. Sun, and B. Jennings; Neutron cross sections at 115 ev and 300 ev, C. T. Hibdon and C. O. Muehlhause; Fast neutron cross sections and nuclear shell structure, D. F. Sherman, D. J. Hughes, and J. R. Wallace; Total cross section of carbon and hydrogen for fast neutrons, E. E. Lampi, G. Freier, and J. H. Williams; Small angle scattering of neutrons, D. Meneghetti; Neutron resonance scattering by W^{186}, S. Harris and C. O. Muehlhause; Widths of neutron resonances, L. L. Lowry and M. Goldhaber; Resonance neutron activation of "even-even" nuclei, A. W. Sunyar and M. Goldhaber; Ionization of neon by atomic projectiles of neon, John H. Martin; Meson production in a photo-nuclear collision, Melvin Lax; Creation of mesons by high energy nucleons, E. Strick; Fourth-order interaction between nucleons in the pseudoscalar meson theory, H. A. Bethe; Interaction representation for mesons, Frederik J. Belinfante; On the classical theory of the electron, Alfred Landé; Invariant theoretical determination of position operators, T. D. Newton and E. P. Wigner; Covariant field theories, Peter G. Bergmann and Johanna H. M. Brunings; Operator matrices for relations of space and time intervals. Richard Schlegel; Basic electromagnetic theory and the correspondence principle. Herman M. Schwartz; The approximate solution of certain boundary value problems involving moving boundaries, Howard Reiss and Victor K. La Mer; On the uncertainty principle, Gertrude Schwarzmann; The structure of the extensive cosmic-ray showers, G. Cocconi, V. Cocconi Tongiorgi, and K. Greisen; Neutrons in the cosmic radiation, Vanna Cocconi Tongiorgi; Radioactive tin 121, 123, and 125. J. C. Lee and M. L. Pool; Neutron-proton scattering, K. M. Watson and J. V. Lepore.

1430 Proceedings of the American Physical Society. *Phys. Rev.* 76, 584-93(1949) Aug. 15 (Minutes of the meeting at the University of Washington, at Seattle, Washington).

The invited papers presented at the 294th meeting of the American Physical Society, which was held at the University of Washington, Seattle, on June 27-29, included the following: Recent advances in quantum electrodynamics, R. P. Feynman; High energy gamma-rays from the cyclotron target, Burton J. Moyer; Proton-proton scattering, Wolfgang K. H. Panofsky; Recent theoretical work at the radiation laboratory, M. L. Goldberger; Nuclear spectroscopy, W. A. Fowler; Isotopes in stellar atmospheres, Andrew McKellar; Scattering and reactions of protons on tritons, R. F. Taschek; Direct crystal spectroscopy of gamma-radiation, David A. Lind; The new California Institute electrostatic generator, J. E. Perry. Abstracts of the contributed papers are given which include the following: Transients in the phenomena of nuclear induction, E. A. Uehling; Nuclear induction proton signals below noise level from gases at one atmosphere, F. Bloch and David H. Garber; Nuclear resonances in rotating magnetic fields, E. H. Rogers and H. H. Staub; Solenoidal beta-ray spectrometer with uniform magnetic field, F. H. Schmidt; Neutron polarization, J. Fleeman and H. H. Staub; Proton induced activities in tantalum, J. W. Burkig and J. Reginald Richardson; The Q value for $B^{10}(p\alpha)Be^{7}$, C. Y. Chao, C. C. Lauritsen, and A. V. Tollestrup; Magnetic analyzer for electrostatic generators, D. B. Duncan; Application of proportional counter to p--α reactions at 100 Kev, A. W. Schardt, E. J. Woodbury, and W. A. Fowler; Operation of a linear electron accelerator, G. E. Becker and D. A. Caswell; A high intensity cyclotron, E. J. Lofgren; Total cross sections of nuclei for 40-Mev neutrons, R. H. Hildebrand and C. E. Leith; Range-energy relations for high energy protons in photographic emulsions, H. Bradner, A. S. Bishop, and W. H. Barkas; Improved mass values for π^-, π^+, and μ^+ mesons, A. S. Bishop, H. Bradner, and F. M. Smith; Yield of negative π-mesons produced by high energy protons as a function of proton energy, Stanley B. Jones and R. Stephan White; Temperature dependence of structure of thin silver films, Gerald W. Johnson; Surface self-diffusion of silver on thin single crystals, Gerald W. Johnson and T. Watanabe; Experimental method for determining relative stopping power, John G. Teasdale; Branching ratio in Be^{7} decay, C. M. Turner; Angular distribution of 10.8 Mev deuterons scattered by deuterons, E. J. Stovall, Jr., J. C. Allred, K. W. Erickson, and J. L. Fowler; On the theory of neutron reflectors for chain reacting spheres, G. M. Volkoff; Precision measurement of half-lives, Lorna M. Silver; Absorption of alpha particles in gases, G. G. Eichholz and N. J. Harrick; The half-life of the positive π meson, E. A. Martinelli; N-P scattering experiments at 280 Mev, E. Kelly, C. Leith, and C. Wiegand; Nuclear cross sections for 95 and 270 Mev neutrons (measured with bismuth fission chambers), J. DeJuren, N. Knable, and B. Moyer; Total cross sections of nuclei for 380-Mev neutrons, R. Fox, C. Leith,

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K. McKenzie, and L. Wouters; The energy dependence of several organic and inorganic counter, R. H. Davis and J. D. Graves; Temperature dependence of a scintillation counter using several organic and inorganic phosphors, G. E. Koch and J. D. Graves; A calibrated x-ray film badge dosimeter, E. Tochilin, R. H. Davis, and J. Clifford; The RCA 1P21 photo-multiplier tube as a gamma-ray detector, J. D. Graves and G. E. Koch; A portable high intensity magnet and cloud chamber for use in cosmic-ray research, D. S. Potter, J. E. Henderson, C. E. Miller, and Jay Todd, Jr.; Cosmic-ray protons at 3.4 Km, Jay Todd, Jr., J. E. Henderson, C. E. Miller, and D. S. Potter, The penetrating component of cosmic-rays at 3.4 Km, C. E. Miller, J. E. Henderson, D. S. Potter, and Jay Todd, Jr.; A precision determination of the energy of the 1.1 and 1.3-Mev gamma-radiations from Co^{60} by direct crystal diffraction, D. A. Lind, J. R. Brown, and J. W. M. Dumond; Some results in the scattering theory of the Dirac equation, G. Parzen; A logical extension of the field equations of general relativity, Cornelius Lanczos; An electrodynamic examination of the hydrogen atom, Dan McLachlan, Jr.

1431 Absolute beta counting. Benjamin P. Burtt. *Nucleonics 5*, 28-43(1949) Aug. (See also NSA 3-822).

The comparison method of absolute β counting using end-window Geiger-Müller tubes, is considered in detail and the results of experiments have been applied to obtain various procedures and corrections. The following are treated: (1) A detailed procedure for determining the corrected efficiency of an end-window Geiger counter using RaE obtained from discarded radon tubes. (2) The determination of the effects of absorption and scattering on the counting rates of Co^{60} (0.3 Mev), for I^{131} (0.6 Mev), for RaE (1.17 Mev), and for P^{32} (1.72 Mev). (3) A study of the various factors that affect backscattering corrections for many common sample mountings. (4) The quantitative effects of lateral and vertical displacements of the source on β-counting rates. (5) A detailed procedure for the determination of the absolute disintegration rate of β emitters using a RaE standard. 16 figures, 6 tables, 11 references.

1432 Absolute speed gauge for high voltage particles. W. Altar and M. Garbuny. *Phys. Rev. 76*, 496-501(1949) Aug. 15.

A precision method has been devised to measure nuclear reaction voltages, and equipment has been built capable of measuring reaction energies of charged heavy particles in the Mev range with accuracies of ~ 0.1%. Limitations of the operation are discussed, and the possibility of a direct determination of the electronic charge-to-mass ratio and related fundamental constants is pointed out. To verify the conclusions reached, test runs have been carried out with electron beams, and performance was as expected.

1433 Amplitude bridge for detection of nuclear resonance. H. A. Thomas and R. D. Huntoon. *Rev. Sci. Instruments 20*, 516-17(1949) July.

A circuit for detecting nuclear resonance absorption is described that, unlike the r-f bridge, is simple to construct and adjust and very insensitive to microphonics. The voltages in two branches of an r-f network, one of which contains the coil and sample, are rectified by diode detectors and the audio outputs combined in such a way that noise modulation from the r-f generator is balanced out but the desired signal is not. Experimental performance is discussed and typical signal-to-noise ratios are given.

1434 Dead time and non-linearity characteristics of the Geiger-counter x-ray spectrometer. Leroy Alexander, Elizabeth Kummer, and Harold P. Klug. *J. Applied Phys. 20*, 735-40(1949) Aug.

Several of the present-day methods for non-linear response corrections have been tested and compared since the satisfactory use of Geiger-counter methods for the measurement of diffracted x-ray intensities requires such corrections in the observed counting rates. Both the multiple-foil method of calibrating the non-linearity of response and the two-source method of Beers for the measuring counter dead time have been found to be unsatisfactory approaches to this problem. Experiments have indicated that electronically controlled oscillographic techniques for the direct measurement of dead time are much more satisfactory. With a knowledge of the dead time, τ, the true counting rate, N, can be calculated from the observed counting rate, N_o, by employing the formula $N = N_o/(1-N_o\tau)$. For a pulsating x-ray source the effective counting rate is faster than the observed by a factor which is characteristic of the type of rectification employed, the target material, and the voltage applied to the x-ray tube. A sufficiently accurate value of this factor can be arrived at by oscillographic observation of the pulse pattern and in some cases by mathematical analysis.

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1435 A demountable Geiger-Müller counter using filling gases at atmospheric pressure. J. F. Tait and G. H. Haggis. *J. Sci. Instruments 26*, 269-71(1949) Aug.

A simple demountable counter is described suitable for the assay of tracers emitting low energy β rays. Satisfactory characteristics have been obtained with a helium-ether mixture flowing through the counter at atmospheric pressure. Using this mixture, the counter has a plateau length of 400 v, a plateau slope of 0.01%/v, and a threshold potential of approximately 3250 v. A comparison is made with other methods which have been used for the assay of C^{14} and a table is included showing their relative sensitivity.

1436 The design of an amplifier producing pulses of short duration. T. E. Cranshaw and B. B. Kinsey. BR-453, June 1, 1944. 10p.

The design of an amplifier producing pulses of short duration is described, and circuit diagrams are given. The duration of the pulses has been measured by a coincidence method. The shortest duration without appreciable loss of signal/noise ratio is of the order of a few μsec. Under practical conditions with proportional counters, the signal/noise ratio is roughly the same as with amplifiers producing pulses of much longer duration as reported in another paper (T. E. Cranshaw and B. B. Kinsey: "A study of signal/noise ratio in standard linear amplifiers," 1944).

1437 Fading of proton tracks in vacuum. K. B. Mather. *Phys. Rev. 76*, 486-7(1949) Aug. 15.

The fading of the latent images due to protons has been compared for photographic emulsions maintained in air and in vacuum after the exposure was made. The fading in vacuum was found to be approximately 10% of that in air, indicating a purely chemical origin for the phenomenon of fading. At the present time it is speculative whether the residual 10% arises from the same source, in which case it could be eliminated by merely improving the vacuum, or comes from an altogether distinct process. Some suggestions are advanced concerning a possible Ag atom evaporation process.

1438 The fogging of photographic film by radioactive contaminants in cardboard packaging materials. J. H. Webb. *Phys. Rev. 76*, 375-80(1949) Aug. 1.

Experimental evidence is given which indicates that radioactive fission products resulting from the detonation of the first atomic bomb in July 1945, in the state of New Mexico, were detected by photographic means on paper stock derived from raw products and manufactured in a paper mill at a location approximately 1,000 miles from the point of detonation. Strawboard material coming from that distance which was used for packaging photographic sensitive film, was found to possess contaminated spots which were the result of strong β activity. Measurements of the β activity showed a maximum energy of about 0.6 Mev and a half-life of approximately 30 days. Radiochemical studies of the active ash from the strawboard indicated that the material was of the rare earth series. The energy value and half-life of the β radiation are compatible with the isotope, Ce^{141}. To the author's knowledge this represents the only case of detection of fission products at a ground station so remote from the point of detonation.

1439 A Geiger tube for liquid radio activity measurements. E. J. Harris. *J. Sci. Instruments 26*, 245(1949) July (Laboratory and workshop notes).

A counter design which permits the accurate location of a liquid sample of a radioactive material with reference to the counter is described. The thin-walled counter tube is made a fairly good fit in the solution cup, so that only 1-2 ml of liquid are required.

1440 Group coincidence discrimination. S. W. Lichtman. Naval Research Laboratory Report NRL-P-3477. June 1, 1949. 16p.

A gated discriminator of wide flexibility is described wherein selective discrimination is achieved by grouping desired circuit functions in a mixer unit composed of diode elements. The method is suitable for sorting single and coincident events originating among a multiplicity of separate signal sources and is shown applied to a seven-channel discriminator excited from Geiger tubes. Performance of this equipment is not critically dependent upon wave shape or amplitude of the exciting pulses. No adjustments are required and the equipment is designed for long periods of continuous operation.

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1441 Life tests on self-quenching Geiger-Mueller tubes with halogen and polyatomic gases as quenching agents. F. W. Brown, III and P. J. Harris. Naval Radiological Defense Laboratory Interim Report, Apr. 6, 1949. 13p.

Several tubes have been filled with A as a counting gas, and ethyl alcohol, ethylene, amyl acetate, or 1-butene as the quenching gas. These tubes were counted at a rate of about 3,000 counts per sec and the plateaus were measured at selected intervals. The lifetimes were 1.0×10^9 for ethyl alcohol, 3.0×10^9 for ethylene, 1.2×10^{10} for amyl acetate, and 1.3×10^{10} total count for 1-butene. Mass spectrographic analyses have been completed giving the breakdown products of the quenching gases. Tubes have been filled with a mixture of Ne and A as the counting gas, and Cl as the quenching agent. These tubes have been counted at a rate of 6,000 counts/sec and are giving good results after having counted 8.6×10^{10} counts. Indications are that their lifetime is limited only by absorption or by chemical removal of the Cl.

1442 Mains Geiger and scintillation probe monitor AEP 1903S. National Research Council of Canada Report IM-4, Jan. 1949. 8p.

The Geiger and scintillation probe monitor is described as a transportable mains-operated instrument capable of measuring low values of α, β, or γ radiation with a probe at distances up to 100 ft from the main instrument. Components and operation of the instrument are described and its accuracy indicated.

1443 A new pulse amplitude-discriminator circuit. E. H. Cooke-Yarborough. *J. Sci. Instruments 26*, 96-7(1949) Mar.

A circuit is described whichdiscriminates against pulses smaller than those it is desired to count and which provides a known constant dead time, enabling counting losses to be accurately determined without complete knowledge of the resolving time of other equipment in the counting chain. These counting losses are calculated and the condition whereby the counting rate is independent of the input pulse width is deduced. The circuit is suitable for use when pulses of varying amplitude are to be counted, such as those obtained from an ionization chamber.

1444 On the efficiency of gas counters filled with carbon dioxide and carbon disulphide. R. C.Hawkings, R. F. Hunter, and W. B. Mann. *Can. J. Research 27*, 555-64(1949) June.

The efficiencies of compensated gas counters filled with carbon dioxide and carbon disulfide have been investigated for the purpose of determining absolute disintegration rates of $C^{14}O_2$ samples. In addition to comparing compensated counting units of different radii, a special counter has been constructed to determine the efficiency at different radii using a collimated beam of electrons from Tl^{204}. The carbon dioxide and carbon disulfide filled counters have been shown to be at least 97% efficient.

1445 On the temperature dependence of counter characteristics in self-quenching G-M counters. Om Parkash. *Phys. Rev. 76*, 568-69(1949) Aug. 15 (Letter to the editor).

The temperature dependence of the counter characteristics of Geiger-Müller counters of self-quenching type has been investigated using two counters, one having an internal cathode, the other having an external cathode. The temperature range investigated was 8-60°C. The plateau curves obtained for the two counters at various temperatures indicate that although there was practically no change in counting rate for the external-cathode counter, the counter having an internal cathode exhibited a marked effect at the lower temperatures, i.e., below 18°C the plateau decreases and it disappears at about 9°C. The decrease in plateau width and its disappearance at lower temperatures in the case of a counter with internal cathode might be explained on the supposition that some of the quenching vapor condenses forming semi-conducting paths between the cathode and the central wire, thus giving rise to spurious counts.

1446 Preparation of silver bromide precipitates for radioactivity measurements. F. P. W. Winteringham. *Nature 164*, 183-4(1949) July 30 (Letter to the editor).

For precise measurements of solid activities depending upon moderate- or low-energy β emission it is necessary to prepare solid samples in a geometrically uniform and reproducible manner. A technique has been developed for AgBr precipitates which combines the convenience of precipitation and filter paper collection, and the advantage of mounting on a permanent metal disk and wh ich lends itself to precise weighing and handling without fear of damaging the precipitate. The soluble bromide (including added carrier) is precipitated as AgBr (10-15 mg) and coagulated by rotation. The collected precipitate is washed with acetone and then pressed on a Pb disk by means of a brass cylinder at 140°C so that the filter papers can be peeled away

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leaving the precipitate as a hard flat disk. In a series of 20 assays of a solution of active bromide, over a period of about three half-lives (3 x 34 hr), the overall coefficient of variation was ± 1.8% on total counts of 10^4. The precipitate thicknesses varied from 6.2 to 43.7 mg/cm^2.

1447 Radioactive standards and methods of testing instruments used in the measurement of radioactivity. L. F. Curtiss. *Proc. I.R.E.* 37, 913-22(1949) Aug.

A summary of the program for standardization of radioisotopes at the National Bureau of Standards is given with some of the reasons for need of absolute measurements of radioisotopes in particular uses. This is accompanied by an outline of some of the methods used to determine the characteristics of commercial instruments for the measurement of radioactivity. 14 figures.

1448 Reflection method of determining preferred orientation on the Geiger-counter spectrometer. Michael Field and M. Eugene Merchant. *J. Applied Phys.* 20, 741-6(1949) Aug.

A rapid and accurate method of determining preferred orientation in the surface of thick samples was devised using a reflection technique on the Geiger-counter spectrometer. By presenting the specimen face to all possible angles with respect to the incident x-ray beam, through use of a special fixture, and recording the intensity of diffraction on a potentiometer recorder, the relative number of planes of a given set at each orientation can be determined. The change of intensity due to the positioning of the specimen face away from the Bragg angle is taken care of by a correction formula which is experimentally verified. The method is especially valuable for dealing with thin layers on thick specimens.

1449 Scintillation counters using organic compounds. G. N. Harding, B. H. Flowers, and J. S. Eppstein. *Nature* 163, 990(1949) June 25 (Letter to the editor).

In view of the conflicting data reported by various investigators, further experiments have been made on the efficiency of anthracene, stilbene, naphthalene and KI, used in conjunction with photomultipliers, as detectors of ionizing radiations. Measurements were made using 5.3-Mev α-particles from Po, and 6.04 and 8.78-Mev α-particles from Th C+ C′. Thin crystals, about 2 mm square and 15 mg/cm^2 thick, were used. Curves of the pulse-height distributions obtained are shown. The ratios of pulse-heights for the Th C′ α-particle group are approximately 8:4:2:1 for KI, anthracene, stilbene, and naphthalene, respectively, It was also found that anthracene gave larger pulses than stilbene for both β-particles and γ-rays. Further preliminary measurements indicate that whereas KI + Tl gives a linear relation between pulse-height and α-particle energy, the organic phosphors do not. The purification methods used in preparing the crystals are discussed and compared.

1450 A simple combined coincidence and anti-coincidence circuit. E. H. Cooke-Yarborough and J. L. Putman. *J. Sci. Instruments* 26, 240-1(1949) July.

A simple circuit is described which is capable of recording simultaneously the coincidences and anti-coincidences between pulses from two sources. The circuit could be extended to record various combinations of coincidences and anti-coincidences between pulses from a number of sources.

1451 Spurious counts in Geiger counters and the pretreatment of the electrodes. J. D. Louw and S. M. Naude. *Phys. Rev.* 76, 571-2(1949) Aug. 15 (Letter to the editor).

The effects of pretreatment of the electrodes, consisting of grinding or polishing, on the counting rate of Geiger-Müller counters have been investigated to confirm Kramer's findings, *Z. Phys.* 125, 739(1949). The results obtained for the decay curves of the counting rate of sandpapered metal surfaces of Pb, brass, and Fe are given; in addition, curves showing a temperature effect which is related to the pretreatment are given. Confirmation of Kramer's results were obtained since it was determined that: (1) Metal surfaces which have been ground or polished exhibit strong counting activity when placed in a counter. This activity diminishes with time according to the severity of the pretreatment and differs also in extent for various metals. (2) On heating such a metal surface inside the counter after the activity has died down to the level of the normal background, a gradual, steep rise in counting rate may set in above a certain temperature. The behavior of the metal depends on the nature of the pretreatment, the time elapsed since treatment, and the particular metal.

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1452 Absorbability of heterogeneous scattered x-rays. Hirendra Kumar Pal. *Indian J. Phys.* *23*, 111-8(1949) March.

The absorbability X_ϕ of a heterogeneous beam of scattered x-rays in direction ϕ has been compared to X_{90} for different scatterers and for different primary radiations. In the region of backward scattering, $X_\phi > X_{90}$ invariably, as required by the Compton theory of scattering for homogeneous radiation. The agreement is of the right order of magnitude. In the forward direction, the experimental results may be the classified under the following three distinct types, depending on the average wavelength of the primary beam and the nature of the scattering material. (a) $X_\phi < X_{90}$, (b) $X_\phi = x_{90}$, and (c) those superficially appearing to contradict the Compton theory. An interpretation on the basis of the Compton theory of this anomaly has been attempted.

1453 Absorption of 17.6 Mev gamma-rays in C, Al, Cu, Sn, and Pb. R. L. Walker. *Phys. Rev.* *76*, 527-30(1949) Aug. 15.

The γ-ray absorption cross sections of C, Al, Cu, Sn, and Pb have been measured for the 17.6-Mev γ-rays produced in the $Li^7(p,\gamma)Be^8$ reaction. A γ-ray pair spectrometer was used as a detector for the 17.6 Mev γ-rays in order to avoid counting lower energy quanta produced either in the $Li^7(p,\gamma)Be^8$ reaction, or as secondary radiation in the absorber. The measured cross sections are compared to the sum of the theoretical cross sections for Compton scattering, pair production in the field of the nucleus and pair production in the field of the atomic electrons. For the light elements, the agreement is within the experimental errors of about 1%, but for lead the theoretical value is 10% above the measured cross section. This discrepancy probably results from the use of the Born approximation in the Bethe-Heitler calculation of pair production. The present results are in good agreement with recent measurements of Adams at 11.04, 13.73 and 19.10 Mev, *Phys. Rev.* *74*, 1707(1948), and of Lawson at 88 Mev, *Phys. Rev.* *75*, 433(1949).

1454 The elastic scattering of electrons by neutral hydrogen atoms by the variational method. Su-Shu Huang. *Phys. Rev.* *76*, 477-81(1949) Aug. 15 (See also NSA 2-1834).

Two variational methods are proposed for computing the phase shifts for an electron scattered by a neutral atom. These methods are shown to be different formulations of the same physical principle, i.e., the stationary property of the phase shift. By applying one of these methods to the S scattering of an electron by a H atom, the phase shifts are computed for various kinetic energies. A comparison is finally made with the results which Morse and Allis, *Phys. Rev.* *44*, 269(1933) have derived from the solution of the Fock equation, *Z. Physik* *61*, 126(1930).

1455 History of secondary emission (an electrical engineering 6.502 seminar paper). H. L. Heydt. MIT Servomechanisms Laboratory Report R-135, Mar. 30, 1948. 87p. (NP-974).

When an electron beam strikes any solid material the reflection of some of the electrons of the beam is nearly always accompanied by the emission of secondary electrons from the solid. Many investigations have been undertaken in an attempt to comprehend the precise means by which secondary electrons are released. Only a qualitative understanding is presently available. The secondary electrons have characteristic angular and energy distributions which are worthy of consideration in engineering applications, but the quantity of secondary emission is generally of most importance. The secondary emission yield depends upon the velocity and angle of incidence of the beam of primary electrons as well as the nature and composition of the bombarded surface. Secondary emission is apparently independent of temperature. A rough surface or the application of even a relatively low retarding potential will considerably reduce the number of secondaries that may escape from a bombarded surface. Very high bombarding velocities also result in a decrease in secondary emission. To obtain secondary electron yields greater than those available from elementary surfaces, compound surfaces and surfaces composed of thin layers of several materials have been employed. Some of these complex surfaces will yield on the average more than ten secondary electrons for every impinging primary electron. Such surfaces are finding particular application in the secondary-emission electron multiplier and in the field of picture transmission. 71 references.

1456 A note on perturbation theory as applied to collision stimulated processes. James N. Snyder and W. H. Furry. *Phys. Rev.* *76*, 359-62(1949) Aug. 1.

If a particle which can decay spontaneously is subjected to collisions with other particles, the transition probability may be changed. The calculation of such an effect by the usual time-dependent perturbation methods is complicated by the circumstance that energy can be conserved in some intermediate states because of the possibility of elastic scattering. The perturbation

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calculation is here modified in such a way that the resulting expression for the whole transition probability does not contain any divergences or spurious effects. By suitable approximations the expression is separated into two parts, one of which gives the probability of elastic scattering followed by a spontaneous transition, and the other the true stimulated transition probability which causes a change in the lifetime.

1457 Note on the resonance scattering of high energy γ-rays by nuclei of carbon and copper. E. R. Gaerttner and M. L. Yeater. *Phys. Rev.* 76, 363-4(1949) Aug. 1.

A search has been made for the resonance scattering of high energy γ-rays in nuclei of C and Cu using the 100-Mev betatron to provide the primary radiation. The scattering in C and Cu is less than 1% and 3%, respectively, of the total cross section for resonance absorption.

1458 Pair-production in different elements by γ-rays. R. R. Roy. *Proc. Phys. Soc. (London) 62A*, 499-504(1949) Aug. 1.

The production of electron pairs on bombardment of Pb, Pt, Sn, Ag, and Cu by γ-rays from 200 mg of Ra and its equilibrium products has been investigated. Twelve hundred photographs were taken for each element and the yield was 100 pairs in Pb, 85 in Pt, 72 in Sn, 63 in Ag, and 50 in Cu. The distribution of energy of the positrons in Pb and Pt follows the shape of the theoretical curve of Bethe and Heitler, but the position of the maximum of the energy distribution curves in Sn, Ag, and Cu shows a discrepancy with that to be expected theoretically. The theoretical difference between the average energies of the positrons and electrons in the elements studied, when plotted against Z, is consistently higher than the experimental, though both can be approximately represented by straight lines. The angular distribution of the positrons and electrons with respect to the incident γ-rays agrees with the theory.

1459 Penetration and diffusion of hard x-rays through thick barriers. I. The approach to spectral equilibrium. H. A. Bethe, U. Fano, and P. R. Karr. *Phys. Rev.* 76, 538-40 (1949) Aug. 15.

When some of the secondary components of a complex radiation are only slightly "softer" than the primaries, the process of formation and decay of these components alone governs the approach to equilibrium. It is then possible to determine the asymptotic trend of the total radiation intensity at great depths of penetration. Using broad assumptions, this trend has been evaluated as $x^{k_0} \exp(-\mu_0 x)$.

1460 Theoretical interpretation of proton-proton scattering. John David Jackson. MIT Laboratory for Nuclear Science and Engineering Technical Report No. 29 (Office of Naval Research Contract). July 15, 1949. 179p.

The problem of the theoretical interpretation of proton-proton scattering data is considered. Simplified formulas for the determination of the phase shifts from the experimental cross sections are given, along with the numerical expansions and tables necessary for their use. The concept of an "apparent S-wave phase shift", δ_a, is introduced to facilitate the analysis of the experimental data for P-wave and D-wave anomalies in addition to the S-wave scattering. The auxiliary functions needed in conjunction with the apparent S-wave phase shift are presented in tabular and graphical form.

The phase shifts are determined from the experimental data, and are analyzed in terms of the apparent S-wave phase shift for P-wave (and/or D-wave) effects wherever the accuracy warrants it. It is not unreasonable to expect a detectable P-wave anomaly in the scattering for energies above 2 or 3 Mev. However, the Van de Graaff data available at present in the energy range 2.5 to 3.5 Mev give only an uncertain indication of a repulsive interaction in the ^3P state, and are not inconsistent with no interaction, or a small attraction in the ^3P state. The data above 4 Mev (up to 14.5 Mev), taken with cyclotrons as sources of high energy protons, are relatively inaccurate. They point to a slightly repulsive ^3P interaction (or an attractive ^1D interaction), but again are not inconsistent with purely S-wave scattering.

The S-wave nuclear scattering is analyzed by means of the expression:

$$K = \frac{\pi \cot \delta_0}{1^{2\pi\eta}-1} + h(\eta) = R\left[-a^{-1} + \tfrac{1}{2} r_0 k^2 - P r_0^3 k^4 + \ldots\right]$$

which is a function of the nuclear phase shift, δ_0, and the energy (through η), and allows a representation as a power series in the energy (k^2). The coefficients in the expansion have a simple

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physical meaning: a is the proton-proton Fermi scattering length; r_o is the effective range of the nuclear force; P measures the compactness of the nuclear potential (it is negative for a square well, positive for a Yukawa well). The form of K predicts that the experimental data when plotted against k^2 should lie approximately on a straight line, the intercept of which determines the scattering length, a, and the slope of which determines the effective range of the interaction. The data below 4 Mev do fall very closely along a straight line on such a plot, and determine the valuesa $\tilde{-}$ -7.67 x 10^{-13} cm, $r_o \tilde{-}$ 2.65 x 10^{-13} cm, assuming P and higher coefficients are zero.

The quantities $\sigma\left(\frac{\partial K}{\partial \sigma}\right)_E$ and $E\left(\frac{\partial K}{\partial E}\right)_\sigma$ are evaluated for the energy range 0 - 10 Mev, and are used to discuss the feasibility and usefulness of measurements near the interference minimum in the 90° scattering at 400 kev. It is recommended that careful measurements be made on the scattering at $\theta = 90^\circ$ in the energy range 420-450 kev.

An approximate relation between the proton-proton scattering length and the corresponding neutron-proton quantity is obtained and used to examine the hypothesis of the charge-independence of nuclear forces, as determined from proton-proton scattering and singlet neutron-proton scattering.

The derivation of the expansion of K by variational methods, first done by Schwinger, *Phys. Rev. 72*, 742A(1947) is extended to obtain expressions for the coefficients of the k^4 and k^6 terms in the expansion. The effects of small changes in the potential on the variational parameters is considered, in particular, the effects of changes in range and strength of the interaction.

Numerical results of calculations carried out for the four usually assumed potentials are presented, along with formulas allowing one to determine the well parameters which will give closest agreement with the experimental scattering, or, alternatively, the variational parameters implied by a particular choice of well parameters. It is found that all four potential shapes give equally good fits to the experimental data, provided the proper range and strength of interaction are chosen. The well parameters and variational parameters giving the best least squares fit to the data for a given potential shape are tabulated. The earlier results of Breit, et. al., *Phys. Rev. 50*, 825(1936); *55*, 1018(1939); *56*, 884(1939), are, in general, confirmed although more recent experimental data have modified (and narrowed down) the numerical values somewhat.

The experimental accuracy necessary to distinguish between the extremes in well shapes (the square and Yukawa wells) at 10 Mev is examined. It is found that by careful use of existing equipment, measurements with the necessary accuracy could be made; such measurements are recommended.

Estimates are given for the phase shifts of higher angular momenta for the four usual well shapes. The S-state Coulomb wave functions are discussed in some detail in an appendix, particular emphasis being placed on the irregular solution G(r). An expansion for G(r) in powers of the energy (k^2) in terms of modified Bessel functions of argument 2(r/R) is obtained, to terms in k^4 inclusive.

1461 Calculation of internal conversion coefficients for the K-shell. John A. Harr and Peter Strong. AECU-403, July 1949. 6p.

The k-shell internal conversion coefficients were computed from the relativistic formulae, using Dirac Wave functions for Z = 10, 20, and 30, and k (γ-ray energy/mc^2) = 0.3, 0.5, 1.0, 1.8, 3.0, and 5.0 for electric (E_μ) and magnetic multipoles (M_μ) of order 2^μ with μ = 1, 2, 3, 4, and 5. This computation is an extension of the tables previously computed for Z = 40, 54, 64, 72, 78, 83, 88, 92, and 96. Formulae used in the computation may be found in MDDC-1514.

1462 Radiation intensities of phosphorus bakelite beta ray sources as calculated from their specific activities. Leon Wish, W. T. Burnett, Jr., and P. C. Tompkins. AECU-411, Aug. 17, 1949. 13p.

The absolute disintegration rate (Q) of phosphorus-bakelite β-ray sources is shown to be determined directly by measurement of the ionization produced by P^{32} bremsstrahlung in a γ-ray ionization chamber which has been calibrated with a standard solution of P^{32}. Using the weight (W) of the activated plaque, the radiation intensity at the surface can then be calculated from the equation $I_{(rep/hr)} = 890\ Q/W$.

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1463 Angular distribution of annihilation radiation. S. DeBenedetti, C. E. Cowan, and W. R. Konneker. *Phys. Rev.* 76, 440(1949) Aug. 1 (Letter to the editor).

A circuit selecting the coincident pulses from two scintillation counters was used to obtain measurements on the angular distribution of the two photons in annihilation radiation. Sources of Cu^{64} surrounded by a Au absorber, in which the positrons were stopped, were used. The curve of the number of γ-γ-coincidences as a function of the position of one of the detectors is shown. The average value of the momentum of the center of mass of the annihilating pairs was found to be approximately 0.9×10^{-2} in units of "mc." This is remarkably close to the value of 0.8×10^{-2} obtained by Dumond, et. al., *Phys. Rev.* 75, 1226(1949), from the shape of the annihilation line from a Cu absorber.

1464 Apparent straggling of $_{16}S^{35}$ beta particles in glass. Mary Jane A. Linker and F. T. Rogers, Jr. *Phys. Rev.* 76, 428(1949) Aug. 1 (Letter to the editor).

The β-spectrum from the decay of S^{35} was measured, using a glass Geiger-Müller counter with a nominal window thickness of 0.001 cm and superficial mass of 2.5 mg/cm^2. The results obtained are tabulated along with the values of the straggling coefficient "ρ" which were calculated from the following relation $\rho \simeq (t\text{-}kE^2)/\text{erfi}^{-1}(1\text{-}2\tau)$. The foregoing expression was derived assuming a Gaussian distribution form such as is applicable for the case of α-particles in air in which scattering does not appreciably affect the distribution function. The results indicate a value of $\rho = 4.4 \times 10^{-4}$ cm with an A. D. of 0.6×10^{-4} cm and the values obtained for ρ are consistent enough to justify the assumption of the simple relationship previously noted.

1465 Beta-decay of In^{115*}. P. R. Bell, B. H. Ketelle, and J. M. Cassidy. *Phys. Rev.* 76, 574(1949) Aug. 15 (Letter to the editor).

A scintillation spectrometer and a magnetic lens spectrometer have been used to investigate the decay of In^{115*} which decays mostly by isomeric transition to the In^{115} ground state. However, a beta-spectrum has also been observed. Curves of the pulse-counting rate as a function of the pulse height are shown for the two spectrometers and a Kurie plot of the lens spectrometer data is also given. The plot is fairly straight and the end-point seems to be 830 ± 20 kev. If the 338-kev γ-ray transition goes to the ground state of In^{115} and the 830 kev β-ray transition goes to the ground state of Sn^{115}, the energy difference between the two ground states would be 490 kev with In^{115} as the unstable member of the pair.

1466 Beta-ray spectra. H. J. Lipkin. *Phys. Rev.* 76, 567-8(1949) Aug. 15 (Letter to the editor).

An unsuccessful calculation to account for the prevalence of β-ray spectra, experimentally found to have the allowed shape in cases where the ft-value would indicate a forbidden transition, is discussed briefly.

1467 Coincidence and absorption measurements on Cs^{134}, I^{124}, Au^{199}, and Ca^{45}. J. Lawrence Meem, Jr. and Fred Maienschein. *Phys. Rev.* 76, 328-32(1949) Aug. 1.

The β-ray spectrum of Cs^{134} was investigated by absorption and β-γ-coincidence measurements. Beta-rays of 0.60 Mev and about 90 kev were observed. In I^{124}, the maximum energy of the β-rays was found to be 2.30 Mev and β-γ-coincidences showed the β-spectrum to be simple. A maximum γ-ray energy of 2.24 Mev was observed with several lower energy γ-rays indicated. Gamma-gamma-coincidences were found, but coincidences between β-particles and internal conversion electrons could not be detected. Au^{199} exhibited a β-ray of 0.32 Mev, and the β-γ-coincidence rate per β-ray was independent of absorber thickness. A maximum γ-ray energy of about 0.21 Mev was found by coincidence absorption of photoelectrons and coincidences between β-particles and internal conversion electrons. Gamma-gamma-coincidences were obtained. The 43-min isomeric state of Hg sometimes attributed to Hg^{199} was not observed to grow from Au^{199}. Ca^{45} was found to have a single β-ray of 0.22 Mev and no γ-rays.

1468 The decay constant of radio-sodium, Na^{24}. R. Wilson and G. R. Bishop. *Proc. Phys. Soc. (London) 62A*, 457-9(1949) July 1 (Letter to the editor).

During the course of some work using radio-sodium as a calibrated source of monochromatic γ-rays, the decay constant was redetermined with the object of enabling accurate estimates of the activity to be made, even after the lapse of several half periods. The method adopted was to measure the ionization produced by the γ-radiation in a large shallow chamber 50 cm in diameter and 6 cm in total depth. The ionization currents obtained were compared with those from a 200 mc radio-thorium standard by means of an electrometer tube which served as a null instrument. Using Gauss's method of least squares, the decay constant was determined from the linear logarithmic plot as 0.04652 ± 0.000062 hr^{-1}.

PHYSICS (continued)

1469 Decay scheme of Te^{125m}. J. C. Bowe and Gertrude Scharff-Goldhaber. *Phys. Rev.* 76, 437-8(1949) Aug. 1 (Letter to the editor).

The decay scheme of metastable Te^{125} has been studied to determine the role of the recently determined transition associated with the production of 31-Kev conversion electrons, *Phys. Rev.* 75, 324(1949). The investigation was undertaken to assign the spin change between the metastable state and the ground state. By means of the fluorescence method recently described, *Phys. Rev.* 62, 83(1942), unconverted photons corresponding to the 35.4-kev transition were detected. It was found that approximately 15 unconverted γ-rays are emitted per 100 x-rays. Using two krypton-filled Eck and Krebs counters and a coincidence circuit with a resolving time of 0.2 μsec, photon-photon coincidences were found which were greatly reduced when Ag absorbers were inserted between the source and one of the counters. The results indicate that this transition precedes the 109.3-kev transition. The absolute efficiency for detecting K shell-holes was determined to be $(1.1 \pm 0.1) \times 10^{-3}$. The lifetime of the 35.4 kev transition is estimated as $< 5 \times 10^{-8}$ sec. It is noted that the experimental data are compatible with either electric dipole or magnetic dipole transitions, although the lifetime seems somewhat short for the latter. A decay scheme is given for metastable Te^{125} which is based on the information obtained.

1470 The forbidden transition of Yttrium^{91} and Cesium^{137}. J. S. Osaba. *Phys. Rev.* 76, 345-9(1949) Aug. 1.

Y^{91} decays by the emission of a single β-particle with a maximum energy of 1.54 Mev, while Cs^{137} decays in two ways, (1) β-decay (maximum energy = 0.518 Mev) to Ba^{137*} followed by a γ-transition to the ground state, and (2) β decay (maximum energy = 1.2 Mev) directly to the ground state. Probably not more than 5% of the Cs^{137} nuclei decay directly to the ground state. Conventional (allowed transition) Kurie plots of Y^{91} and the low energy group of β-particles of Cs^{137} display a curvature which is concave toward the energy axis at high energies and concave upward at low energies. If it is assumed that Gamow-Teller selection rules govern the β-process, the Fermi function $F(Z,W)$ for allowed spectra must be multiplied by a factor $G = (W^2 - 1) + (W_0 - W)^2$ in a β-transition for which there is a change of parity and for which the spin change is two units. If these conventional Kurie plots of Y^{91} and Cs^{137} are modified by the factor G, the resulting plots are approximately straight lines. This indicates that the β-decay of Y^{91} and the low energy β-decay of Cs^{137} involve a spin change of two units and a parity change. These results contribute evidence for the validity of the Fermi theory of β-decay and the Gamow-Teller selection rules. The K internal conversion coefficient for the 0.663-Mev gamma from the decay of Cs^{137} was found to be 0.081, while the ratio of the K conversion electrons to the L conversion electrons was 5.0. The γ-radiation seems to be either magnetic 2^4-pole or electric 2^5-pole.

1471 Gamma-radiation from Na^{22} and Co^{60}. David E. Alburger. *Phys. Rev.* 76, 435(1949) Aug. 1. (Letter to the editor).

Techniques of γ-ray measurement using the lens spectrometer have been applied to the radiation occuring in 3y Na^{22} decay. The experimental method used is due to Hornyak, et. al.(*Phys. Rev.*, in press). The Na^{22} source was produced in a cyclotron by the reaction $Mg^{24}(d,\alpha)Na^{22}$. The average value obtained for the γ-ray energy was 1.277 ± 0.004 Mev. From this the Na^{22}-Ne^{22} mass difference has been determined as 0.003087 ± 0.000011 Mev. As a check on the method the γ-rays of Co^{60} were investigated and energies of 1.175 ± 0.006 Mev and 1.332 ± 0.005 Mev obtained. These agree well with the new crystal spectrometer measurements of Lind, et al., *Bull. Am. Phys. Soc.* 24, No. 6, 12(1949).

1472 The gamma rays of radium (B+C). K. C. Mann and M. J. Ozeroff. *Can. J. Research* 27, 164-7(1949) July.

An experiment has been performed to verify the γ-ray energy spectrum of Ra (B + C) as reported by Latyshev and associates, *Revs. Modern Phys.* 19, 132(1947). The spectrum was obtained by measuring the energies of photoelectrons ejected from a thin Pb radiator by means of a thin-lens magnetic β-ray spectrometer. The spectrum obtained failed to reveal the presence of transitions other than those reported by C. D. Ellis, *Proc. Roy. Soc. (London)* 143A, 350(1934). Comparative results are presented.

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1473 High energy gamma-radiation from $Be^9 + D^2$. C. Y. Chao, T. Lauritsen, and V. R. Rasmussen. *Phys. Rev.* 76, 582-3(1949) Aug. 15 (Letter to the editor).

Using a magnetic lens spectrometer arranged as previously described, *Phys. Rev.* 76, 581 (1949), the high-energy end of the γ-ray spectrum obtained from the bombardment of Be with 1.50-Mev deuterons has been investigated. The source assembly consisted of several layers of Be metal foil, aggregating about 300 kev energy loss at the deuteron energy used, 25 mg/cm^2 of Th metal foil to stop the deuterons and 250 mg/cm^2 of Be metal as a Compton electron source. The resulting momentum distribution of the secondary Compton electrons is shown. The energies and approximate relative intensities of these γ-rays, determined by comparison with the Compton electron distribution from similar converters are given below:

E_γ (Mev)	2.89 ± 0.04	3.35 ± 0.05	3.56 ± 0.06
Relative intensity	2.9	1.8	1.0
E_γ (Mev)	3.97 ± 0.08	4.47 ± 0.07	5.20 ± 0.1
Relative intensity	0.1	0.14	0.04

The difficulty in assigning these rays to particular nuclei is discussed.

1474 Neutron induced radioactivities in V^{52} Mo^{99}, and W^{185}. J. M. Cork, H. B. Keller, and A. E. Stoddard. *Phys. Rev.* 76, 575-6(1949) Aug. 15 (Letter to the editor).

On exposing specimens of V, Mo, and W to neutron capture in the Argonne and Oak Ridge piles, certain new radioactivities were found to be produced. The decay of V^{52} occurred with two half-lives, one of 16 hr and the other of about 635 days. Conversion electrons indicated the existence of γ-rays having energies of 80.5 and 119.3 kev for the long-lived emitter. A half-life of 68.3 hr was observed and attributed to Mo^{99}; the γ-ray spectrum for this isotope included energies of 0.78 Mev and 139.6,167.6, and 179.3 kev. A complex decay curve was obtained for W, showing a half-life of 25.0 hr (previously reported 24.1) and a long-lived emitter of half-life 76 days. Associated with the latter activity is a single γ-ray at 133.7 kev.

1475 On the continuous gamma-radiation accompanying the beta-decay of nuclei. C. S. Wang Chang and D. L. Falkoff. *Phys. Rev.* 76, 365-71(1949) Aug. 1.

The quantum mechanical calculations of Knipp and Uhlenbeck, *Physica* 3, 425(1936), and F. Bloch, *Phys. Rev.* 50, 272(1936), of the continuous γ-spectrum associated with the sudden change of nuclear charge during β-decay have been extended to forbidden β-transitions and to the different types of β-interactions. It is shown that the γ-spectrum has practically the same shape, and the ratio of total γ-intensity to β-intensity is almost the same for forbidden transitions as for allowed transitions, irrespective of the β-interaction. This accounts for the good agreement of the theory for allowed transitions with the experiments of C. S. Wu, *Phys. Rev.* 59, 481(1941), on P^{32}, a "forbidden" β-emitter. A simple classical analogue is given to explain this uniformity and is shown to justify the interpretation that the probabilities for the β- and γ-emission processes may in a very good approximation be taken as independent.

1476 On the γ-γ-angular correlation in Pd^{106}. Daniel S. Ling, Jr. and David L. Falkoff. *Phys. Rev.* 76, 431(1949) Aug. 1 (Letter to the editor)

The theory of γ-γ-angular correlations has been extended to the case in which one of the transitions is a mixture of magnetic dipole and electric quadrupole radiation. Using this theory it is possible to explain the observed correlation in Sr^{88}, Brady and Deutsch, *Phys. Rev.* 72, 870(1947); 74, 1541(1948), which could not be explained by assuming pure multipole transitions. Some consequences of the application of this theory to the experimental data on the γ-γ-angular correlation in Pd^{106} are discussed. It is concluded that the least possible spin for the intermediate state of this isotope must be $J = 2$, and this choice would force pure quadrupole radiation for the lower transition. However, this does not give the necessary agreement, and it is noted that subject only to the reasonable assumption that the ground state has spin zero, at least one of the successive rays must be of octupole or higher order. This only slightly affects the disintegration scheme for Pd^{106} proposed by Peacock, *Phys. Rev.* 72, 1049(1947), i.e., it excludes $J = 1$ for the intermediate state.

PHYSICS (continued)

1477 Radioactive tin 111. R. A. Hinshaw and M. I. Pool. *Phys. Rev.* 76, 358-9(1949) Aug. 1.

A radioactive isotope of a half-life of 35.0 ± 0.5 min has been found in the Sn fraction of Cd bombarded with α-particles. Using electromagnetically enriched Cd the assignment can be made to Sn^{111}. Positrons of 1.45 Mev and x-rays were observed.

1478 Radioactivity of Mo^{91} and Mo^{93}. R. B. Duffield and J. D. Knight. *Phys. Rev.* 76, 573-4(1949) Aug. 15 (Letter to the editor).

Some observations on the properties of the isotopes Mo^{91} and Mo^{93} which have been deduced from betatron experiments are reported. Samples of Mo oxide enriched in Mo^{92} and Mo^{94} were irradiated with 23-Mev betatron x-rays and the radioactive products were examined. The results obtained are tabulated below:

Isotope	Produced by	Half-life	Radiation
Mo^{91}	Mo^{92} (γ,n)	15.5 ± 0.5 min	β^+ 3.7 ± 0.1 Mev no γ
Mo^{91}	Mo^{92} (γ,n)	75.0 ± 5.0 sec	β^+ 2.6 ± 0.2 Mev γ 0.3 Mev

Since the 6.7-hr activity to be formed by Mo^{94} (γ,n) was not observed, its cross section with 23 Mev x-rays must be less than 0.0005 that of the (γ,n) reactions for the other Mo isotopes. It is noted that the existence of the two isomers reported for Mo^{91} means that there are two well-established isomers for all the 49-neutron nuclei with even atomic number from 34 to 42. The prevalence of nuclear isomerism near the end of closed shells has been pointed out by Mayer, *Phys. Rev.* 76, 185(1949).

1479 A revaluation of the gamma radiations from Co^{60} and Zn^{65}. Erling N. Jensen, L. Jackson Laslett, and William W. Pratt. *Phys. Rev.* 76, 430(1949) Aug. 1 (Letter to the editor) (See also NSA 1-1150 and 2-181).

A check of the Fe-free magnetic lens spectrometer previously used to obtain the energy of the γ-radiations from Co^{60} and Zn^{65}, *Phys. Rev.* 75, 458(1949), has been performed in conjunction with a remeasurement of the photoelectric conversion lines from Co^{60}, since Lauritsen's values ("Gamma-ray measurements with a magnetic lens spectrometer," *Phys. Rev.*, to be published) are higher than those reported by the authors. The following revised values were obtained: (1) 1.16_9 and 1.33_1 Mev for the γ-radiations from Co^{60}, and (2) 1.11_8 Mev for the Zn^{65} γ-ray.

1480 The Bose-Einstein condensation for charged particles in a magnetic field. M. F. M. Osborne. *Phys. Rev.* 76, 400-6(1949) Aug. 1.

The condensation and accumulation phenomena of charged Bose-Einstein particles in a magnetic field are examined, neglecting electrostatic interactions. For weak fields a single condensation occurs at the same temperature as that for uncharged particles; for strong fields there is a separate lower accumulation temperature, indicating the accumulation of particles in the lowest translational state. The total energy, free energy, and polarization are calculated, and applied to the properties of a gas, of electron pairs, and a solution of deuterons in a metal, these being systems whose low temperature behavior might show a Bose-Einstein condensation. It is shown that the Bose-Einstein condensation of free electron pairs cannot provide a theory of superconductivity.

1481 The Bose-Einstein condensation for thin films. M. F. M. Osborne. *Phys. Rev.* 76, 396-9(1949) Aug. 1.

The distinction is made between a condensation temperature in the thermodynamic sense, where the thermodynamic functions have a discontinuity, and an abrupt accumulation (in the statistical mechanical sense) of particles in the ground state of a system. The criterion for the latter is that an integral will not approximate one term of a sum. The problem of a thin film of gas is solved to illustrate this distinction. For films thicker than a critical thickness a condensation occurs at the same temperature as that for bulk material. The thinner films are effectively two dimensional and have an abrupt accumulation temperature lower than the bulk condensation temperature. Films of liquid He are briefly considered.

PHYSICS (continued)

1482 The Compton scattering by particles possessing charge and dipole moment. S. Shanmugadhasan. *Proc. Cambridge Phil. Soc. 45*, 411-28(1949) July.

The simplest exact classical theory of a particle possessing charge and dipole moment proportional to the spin leads to a wave equation with an explicit spin interaction with the field. This wave equation is used to calculate the scattering probability coefficient in the Compton effect by two methods. The first method uses the unquantized radiation field; the second uses Dirac's scheme of field quantization. The scattering probability coefficient is given in the general case in terms of the charge e, the constant of proportionality in the dipole moment C, and the quantities k, 1 specifying the spin. Some special results are considered for particles of spin 1/2 and 1. Formulas are given for the scattered intensity as a function of the angle of scattering, and the total scattering cross-section as a function of the energy of the unpolarized incident radiation. Graphs are given for these formulas when the magnetic part of the dipole moment takes the empirical values in the case of the electron, proton, and neutron. In the case of the meson, normal and abnormal values of the dipole moment are used.

PHYSICS (continued)

1483. The computation of wave functions in momentum space. I. The helium atom. R. McWeeny and C. A. Coulson. *Proc. Phys. Soc. (London) 62 A*, 509-8(1949) Aug. 1.

The possibilities of obtaining precise momentum wave functions for atoms by direct solution of the wave equation in momentum space are examined in some detail. An interative method of approximating to the wave function is employed in computing the momentum distribution function for the He atom. Although in this instance considerable accuracy is achieved, formidable difficulties arise in extending the calculations to more complicated atoms.

1484 The computation of wave functions in momentum space. II. The hydrogen molecule ion. R. McWeeny. *Proc. Phys. Soc. (London) 62 A*. 519-28(1949) Aug 1.

A new approach is made to the problem of computing accurate momentum distribution functions for electrons in molecules. The usual molecular orbital wave function (linear combination of atomic orbitals) has already been employed for this purpose but has proved inadequate in attempts to explain the width of the Compton profile. Using the method of a previous paper, McWeeny and Coulson, *Proc. Phys. Soc. (London) Sec. A, 62*, 509-518(1949), the l.c.a.o. type, Coulson, *Proc. Cambridge Phil. Soc. 37*, 55(1941), of molecular orbital is formally corrected by iteration. In most cases it seems likely that the corrected orbital will be associated with a greater spread of the momentum distribution and will thus lead to a broader Compton profile: the broadening should become more marked with increasing delocalization of the electron and may apparently be very considerable. A complete calculation has confirmed these conclusions in the case of the H molecule ion: a preliminary treatment of the neutral molecule is given.

1485 The concepts of mass and energy and the problem of two bodies in kinematic relativity. Maurice Causse. *Compt. Rend. 228*, 542-4(1949) Feb. 14 (in French).

Studying electrodynamical interactions at distances approaching e^2/mc^2, Milne, *(Phil. Mag.* 1943) has demonstrated the conventional character of the energy concept. The concept of potential is, therefore, arbitrary a priori; its definition will depend on that of mass. The author derives these definitions from the study of the problem of two bodies A and B, and shows that the action of B on A is a function of elements relative to A only, i.e., that the criterion of simultaneity need not be used. The energy of all fundamental particles is zero, whatever the degree of condensation of the surrounding matter.

1486 Field mechanical derivation of Dirac's wave equation. F. Z. Bopp. *Z. Naturforsch. 3a*. 564-73(1948) Aug.-Nov. (in German).

An equation of motion is obtained, from a generalized linear electrodynamics, which has been previously discussed by Hönl and Papapetrou. The distinction between the macro-velocity and the micro-velocity of the particle is noted. Owing to an oscillation caused by emission-reabsorption processes the energy and charge center are displaced. An additional moment appears which is found identical with the electron gain when Maxwell's equations are suitably modified. Quantization of the above equations of motion leads to a wave equation whose solutions contain those of Dirac's equation. Particles of slow oscillation are shown to be heavy particles.

1487. Further deductions from the $\aleph$-theorem. Harvey Einbinder. *Phys. Rev. 76*, 410-12(1949) Aug. 1 (See also NSA 1-1470).

For an ideal statistical gas, where PV = sE, all thermodynamic functions can be derived from G(V,T), i.e., A(V,T) is given by a suitable integration over G(V,T). Since G = N μ, the normalization constant, μ(V,T), of the distribution function is sufficient to provide a complete thermodynamic description of such a system. With the aid of the $\aleph$-theorem it is shown that there is a sharp physical distinction between the degenerate and non-degenerate Bose-Einstein gases; to any given density there corresponds a transition temperature between them. The method developed is applied to the general (relativistic and non-relativistic) non-degenerate quantum and degenerate Fermi-Dirac gases.

1488 Infinite representation of the Lorentz-transformation and the mass problem. W. Wessel. *Z. Naturforsch. 3a*. 559-64(1948) Aug.-Nov. (in German).

A theory of particles which results in mass quantization is outlined. The values thus obtained for the mesons masses are in sufficient agreement with the experimental values to support the theory presented.

PHYSICS (continued)

1489 The interaction of point particles with charged fields. K. J. Le Couteur. *Proc. Cambridge Phil. Soc. 45*, 429-40(1949) July.

The method introduced by Dirac, *Proc. Roy. Soc. (London) 167 A*, 148(1938), in his classical theory of the interaction of an electron with an electromagnetic field has since been extended to the interaction of point particles with more general wave fields, such as occur in the neutral meson theory. However, a discussion of the classical theory of the interaction of a nucleon with a charge-bearing field is desirable. The expressions obtained for the cross-sections for the scattering of mesons (negative and positive) by nucleons agree with the results of the quantum-mechanical treatment by elementary perturbation theory. The results obtained are also generalized by the inclusion of a pseudoscalar field.

1490 Mechanics and mass spectrum of fundamental particles. H. Honl. *Z. Naturforsch. 3a*, 573-83(1948) Aug.-Nov. (in German).

The classical dynamics of a new type of particles is developed and mass dipoles and multipoles are introduced in addition to single poles. The dynamics, which is obtained from a suitable Lagrangian leads to a classical analogue of a Dirac particle for the pole-dipole case, but the mass term is more intricate. The correspondence between the classical theory and the quantum theory of mesons is discussed. The classical theory shows a distinction between inner and outer variables corresponding to spin operators and momentum operators. The spin operators of a hierarchy of particles (corresponding to multipole particles) are chosen according to de Broglie's method of fusion. The mass terms are the "center" of the spin operator algebra and its irreducible masses. The mass spectrum of the pole-dipole particle is found by application of the correspondence principle. In concluding the discussion, the theory of the origin of cosmic radiations is treated.

1491 A note on Podolsky electrodynamics. P. T. Matthews. *Proc. Cambridge Phil. Soc. 45*, 441-51(1949) July.

Three formalisms have been considered for the 'extraordinary' field introduced by Podolsky in his generalized electrodynamics, *Phys. Rev. 62*, 68(1942) and 228(1944). (1) The c-representation (tildons) for negative energy particles leads to an unstable vacuum in electron hole theory and must be discarded. (2) The d-representation suggested by Podolsky is a hole theory for bosons. This leads at once to inconsistencies and it is impossible to introduce a Fock representation. (3) The least unsatisfactory is the b-representation (tilde photons) (used in a series of papers by Podolsky, et. al., and summarized by B. Podolsky and P. Schwed in *Rev. Mod. Phys. 20*, 40(1948). Tilde photons can be created at high energies but decay immediately by pair creation. The introduction of tilde photons does not interfere with any agreement already established between experiment and ordinary quantum electrodynamics. Evidence might be obtained for the value of the constant "a" from consideration of the 2S level shift of the H atom and from the theory of showers where the deviation from the usual theory is greatest However, the formalism involves the introduction of an indefinite metric for the tilde photon field and consequently "negative probabilities" for states in which an odd number of tilde photons are present. Approximate results can be obtained by assuming that 'negative probabilities' in the theory are positive probabilities in the real world. This leads to a small but fundamental error, and it does not seem possible that a theory in this form can have any deep-seated validity. The same analysis applies to the extension of the Podolsky theory to the Proca field by Green. *Phys. Rev. 73*, 26(1948). In order that the energy should be positive definite it is necessary to introduce an indefinite metric for one of the two superposed meson fields. Fundamentally the difficulties of interpretation are the same but in practice they will be more obvious because the coupling constants are greater.

1492 On the classical equations of motion of radiating electrons. S. Ashauer. *Proc. Cambridge Phil. Soc. 45*, 463-75(1949) July.

Some of the details of the application of the Lorentz-Dirac equations of motion of an electron to two simple cases, (a) with no incident field, and (b) with an incident pulse of radiation are considered. In case (a), the field-energy distribution in the self-accelerating motion of the electron when the electron has built up a velocity close to the velocity of light is considered. Numerical and graphical methods are used to form a picture showing how the field energy tends to be concentrated in a disk for this state of motion. A discontinuity of the advanced field variables of the self-accelerating electron is also examined. In case (b), the general solution

of the equations of motion for the velocity of the electron is worked out accurately. In the physical solution, this brings out the effects of radiation damping when the pulse has great intensity. Some aspects of the non-physical solutions are pointed out.

1493 On the formalism of a theory of negative and positive electrons. Jean G. Valatin. *Compt. Rend. 228*, 1205-6(1949) Apr. 4 (in French) (See also NSA 3-1305).

An approximate relativistic description of a system of electrons is given, the concept of the positive or negative sign of the electric charge being associated with the geometric concept of duality. Instead of introducing, by a purely formal method, operators with infinite additive constants, it is found more natural to define, in a space of states, only operators without infinite constants. The difficulty of defining the operator V in an exterior field shows that, any introduction of an exterior field being an approximation, the starting point in a theory of interactions should be the establishing of a fundamental system of free particles, in which interactions with other kinds of particles can be described by introducing the states of the latter in an analogous way.

1494 On the part played by scalar and longitudinal photons in ordinary electromagnetic fields. Frederick J. Belinfande. *Phys. Rev. 76*, 226-33(1949) July 15.

When electromagnetic interactions are calculated directly by second-order perturbation calculus without preceding separation of the Coulomb field from the transverse photon field by a canonical transformation, it is fundamentally not allowable to take a state without photons as a zero-order approximation. A more correct zero-order approximation is determined, in which scalar and longitudinal photons are present in pairs. The probability distribution over the numbers of pairs present is given by the Schrödinger functional equation; these numbers are not limited. No transverse photons are present. The relativistic invariance of such a zero-order approximation is proved. This zero-order approximation is then used for the calculation of the self-energy of a free electron at rest, of the Møller matrix element for electron-electron scattering and of the Breit interaction energy between electrons in an atom. Apart from mathematical ambiguities in the derivation of the self-energy, this leads to the same results as can also be obtained by the usual separation of the Coulomb field from the transverse photon field.

1495 On the treatment of quantum electrodynamics without eliminating the longitudinal field. Ning Hu. *Phys. Rev. 76*, 391-6(1949) Aug. 1.

It is shown that the supplementary condition in quantum electrodynamics can be satisfied identically without eliminating the longitudinal components of the electromagnetic field, provided certain rules on the summation over the polarizations of the photons are observed. The result is shown to be identical with that obtained by the usual method in which the longitudinal field is eliminated. This greatly simplifies the calculation since no separate treatment of longitudinal and transverse fields is needed.

1496 Reciprocity theory of electrodynamics. Max Born, K. C. Cheng, and H. S. Green. *Nature 164*, 281-2(1949) Aug. 13 (Letter to the editor) (See also NSA 2-829; 2-1560; 2-2016; 3-857).

The previously discussed application of the reciprocity theory of electrodynamics to the theory of elementary particles, for the determination of the natural rest masses, *Nature 163*, 207-208, 367(1949), has been extended to electrons and the electromagnetic field as a means of eliminating the divergence difficulties of the orthodox theory.

1497 Remarks concerning the hydrogen eigenfunctions in Dirac's theory. H. A. Bethe. *Z. Naturforsch. 3a*, 470-7(1948) Aug.-Nov. (in German).

A simple derivation of Dirac's virial theorem is given. Using this, it is shown that the value of Dirac's operator β in a Coulomb field is W/mc^2. Dirac's eigenfunctions in momentum space are calculated for both positive and negative energies. The mean values of potential and kinetic energy are calculated, including terms of the order of Sommerfeld's fine-structure constant without the use of explicit relativistic eigenfunctions.

1498 Separation of the variables in the one-particle Schroedinger equation in 3-space. Luther Pfahler Eisenhart. *Proc. Natl. Acad. Sci.* 35, 412-8(1949) July.

The separation of the variables in the one-particle Schroedinger equation in Euclidean 3-space is performed.

PHYSICS (continued)

1499 Two-component wave equations. C. W. Kilmister. *Phys. Rev.* 76, 568(1949) Aug 15 (Letter to the editor)

It is shown that by modifying Eddington's method (Relative Theory of Protons and Electrons; Cambridge University Press, London, 1936) of deriving Dirac's equations, an equation additional to Dirac's and simpler in form, which may, under certain circumstances, be put in two-component form, may be obtained. This differs somewhat from Jehle's equation, *Phys. Rev.* 75, 1609(1949), but its derivation suggests that it is the two-component equation most likely to have physical interest.

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BIOLOGY AND MEDICINE

1500 Medical control of beryllium poisoning. Irving R. Tabershaw, Cyril Dustan, and Leonard J. Goldwater. *J. Ind. Hyg. Toxicol.* 31, 227-33(1949) July.

This report offers a detailed program for the medical control of persons exposed to beryllium and its compounds. The recommendations are based on data gathered in studies of plants producing beryllium salts from beryl ore. The literature was reviewed and a summary made of the essential information now available which is pertinent to designing medical procedures for the prevention of beryllium poisoning and for the care and follow-up of workers exposed to beryllium and of those with overt or suspected acute or chronic disease due to beryllium or its compounds. Recommendations are made with regard to the scope of, and the interval between, physical examinations as well as to the medical handling of persons who possibly are suffering from beryllium poisoning. Medical criteria are suggested for the elimination of the unfit applying for work in plants using beryllium.

1501 Capillary permeability: rate of transcapillary exchange of chloride in the guinea pig as determined with radiochloride. Dean B. Cowie, Louis B. Flexner, and Walter S. Wilde. *Am. J. Physiol.* 158, 231-6(1949) Aug. 1.

The results of an experiment to determine the rate of transcapillary exchange of chloride using radio-chloride as the tracer are presented. The radiochloride (Cl^{38}) was prepared from KCl by deuteron bombardment in a cyclotron. Ten adult guinea pins were used; sodium radio-chloride was injected into the vein of a foreleg of each of the animals; and blood samples were taken from the carotid artery. The technique and method are described in detail. The results were compared to those previously obtained for water and sodium and it was found that in guinea pigs 64% of the plasma chloride is exchanged each minute with extravascular chloride; 60% of the sodium and 146% of the plasma water are exchanged in the same period of time. It is believed that the whole capillary wall is permeable to chloride, sodium and water, and that chloride and sodium do not escape by way of the intercellular cement alone. Diffusion rather than filtration is concluded to be the predominant process in the exchange of substances across the capillary wall. 10 references.

1502 The distribution of radioactive iodine in rats with and without Walker tumor 256 after injection of radioactive sodium iodide. Charles D. Stevens, Paul H. Stewart, Patricia M. Quinlin, and Mary Ann Meinken. *Cancer Research* 9, 488-97(1949) Aug.

At intervals up to four days after the subcutaneous injection of 0.8 ml/100 g body weight of sodium iodide containing 18.2-18.8 mc of radioactive iodine I^{131} into young male rats, the animals were killed and the concentrations of the injected iodine in a number of their tissues were measured. It was found that: (1) The majority of rats with implants of Walker tumor 256 had lower concentrations of the injected iodine in their thyroid glands and other tissues than did control rats grouped with them according to size and treated similarly. (2) The distribution of injected iodine was like that of chloride during the first day after injection in the majority of tissues examined. (3) The concentration of injected iodine in the tissues at one-half hour after injection changed during the 11-day period in which animals were killed; the concentration in the thyroid increased, and the concentrations in the other tissues decreased. In this period the surviving rats increased 70% in body weight. (4) The decrease in concentration of that part of the injected iodine which remained in solution after precipitation of the serum proteins with trichloroacetic acid did not occur as a simple logarithmic function of time during the four days after injection; this was true after the injection of either 0.07 or 70 μg of iodine/100 g of body weight. 29 references.

1503 Measurement of regional circulation by the local clearance of radioactive sodium. Seymour S. Kety. *Am. Heart J.* 38, 321-8(1949) Sept.

A method is described for determining the amount of circulation present within a particular tissue area. The method consists of the injection of radioactive sodium into the site of the tissue in question, and a subsequent determination of the rate of decrease of the activity at the site; the technique and the method of calculation are described. It was theoretically predicted and empirically found that the sodium concentration at the site decreases along an exponential curve, the slope of which, plotted semilogarithmically, is a constant called the clearance constant. It is suggested that the clearance constant represents a valid and convenient measure of the local circulation. 8 references.

BIOLOGY AND MEDICINE (continued)

1504 Metabolism of cardiac muscle: utilization of C^{14} labelled pyruvate and acetate by rat heart slices. O. H. Pearson, A. Baird Hastings, and H. Bunting. *Am. J. Physiol. 158*, 251-60(1949) Aug. 1.

The determination of the factors affecting the measurement of respiration of the rat ventricle slices was made through the use of C^{14}. Wistar-strain rat hearts were excised as rapidly as possible, placed in a phosphate buffered medium and sliced; the ventricles were then separated and their respiration rates were measured in a Warburg apparatus. Potassium pyruvate labelled with C^{14} in the α position and sodium acetate with C^{14} labelled in the carboxyl position were combined with the muscle slices and the amount of substrate that was oxidized to CO_2 was determined as well as the incorporation of the tracer into certain tissue components. The effects of thickness of the tissue slices, anoxia, changes in the ionic pattern of the incubating medium, addition of various substrates and the duration of the incubation were determined in separate experiments. The results show that of the total amount of pyruvate which disappears, approximately 69% is oxidized to CO_2, 20% is reduced to lactate and less than 1% is incorporated into tissue fat and protein. Labelled acetate added alone is readily oxidized to CO_2 by the rat ventricle and accounts for 40-60% of the oxygen consumption. The conversion of acetate to CO_2 in the presence of pyruvate is less than half that observed when acetate was the only added substrate. 13 references.

1505 Utilization of phosphorus as affected by placement: I. Corn in Iowa. George Stanford and L. B. Nelson. *Soil Sci. 68*, 129-35(1949) Aug.

Studies determining the relative efficiency of phosphorus utilization by corn with different placements of superphosphate, through the use of P^{32} as a tracer are described; the radiophosphorus was introduced in the superphosphate material. The results show that the percentage of the phosphorus derived from the fertilizer was influenced by the position of the fertilizer in respect to the seed, and varied according to the stage of growth. The placement of the fertilizer at seed depth and in bands on one or both sides of the seed generally resulted in a greater utilization of the applied phosphorus by the plant than placement in a single band above the level of the seed or in a single band 3 in. below the seed.

1506 Utilization by plants of phosphorus in farm manure: II. Availability to plants of organic and inorganic forms of phosphorus in sheep manure. Clayton McAuliffe, Michael Peech, and Richard Bradfield. *Soil Sci. 68*, 185-95(1949) Aug.

The utilization by plants of phosphorus from manure and superphosphate, when these two phosphorus sources were applied separately and together, was determined in a greenhouse experiment using Italian rye grass as the indicator crop by means of radiophosphorus. The phosphorus fertilization had little effect on the yield of the rye grass; the phosphorus content of the plants increased greatly with successive cuttings and, in general, the plants that received manure contained a higher percentage of phosphorus than those receiving only superphosphate. The phosphorus content of the plants was lower when the fertilizer materials were placed in a band than when they were thoroughly incorporated into the soil. It is concluded that isotopic exchange and biological conversion of phosphorus may decrease the specific activity of phosphorus in the plants and affect the interpretation of results. 22 references.

1507 Utilization of phosphorus from various fertilizer materials: III. Oats and alfalfa in Iowa. George Stanford and L. B. Nelson. *Soil Sci. 68*, 157-61(1949) Aug.

Three experiments were conducted in Iowa on Clarion loam of pH 5.6 and on two Webster silty clay loam soils of pH 6.0 and pH 6.7 to determine the relative effectiveness of four different phosphate fertilizers as sources of phosphorus to oats and alfalfa. P^{32} was employed as a tracer in the phosphorus compounds. The tracer studies revealed that the percentage of phosphorus in the oat plant derived from the fertilizer differed with various phosphate carriers; in every instance, a greater proportion of phosphorus was derived from superphosphate than from any of the other carriers investigated. Young alfalfa also derived a greater proportion of phosphorus from superphosphate than from the other carriers.

BIOLOGY AND MEDICINE (continued)

1508 Utilization of phosphorus from various fertilizer materials: IV. Sugar beets, wheat, and barley in Colorado. Sterling R. Olsen and Robert Gardner. *Soil Sci. 68,* 163-9(1949) Aug.

Experiments on calcareous soils determining the effects of source of material, placement and crop species on the uptake of phosphorus from different fertilizers through the use of P^{32} are described. Superphosphate supplied the largest amounts of phosphorus to the plants especially during the earlier stages of growth. Deeper placement of the fertilizer was, in general, superior to a more shallow placement.

1509 Biological effects of roentgen rays of various wavelengths. V. V. Brunst and E. A. Sheremetieva-Brunst. *Am. J. Roentgenol. Radium Therapy 62,* 252-6(1949) Aug.

In order to compare the biological effects of different kinds of roentgen rays, two series of experiments were performed; 510 adult tritons (Triton cristatus) were used as the experimental animals. Doses of 500-10,000 r were administered in equal amounts to the tails of the tritons in both series; in the first series unfiltered, low voltage roentgen rays were used, and in the second series high voltage roentgen rays were applied. The technique and methods used are described. The results of the experiments indicate that some biological effects of the soft and hard roentgen rays are identical (the mortality of the treated animals, frequency of necrosis, absence and presence of tail regeneration and the mean length of the regenerates). There was a large difference noted in the structure of the regenerated portions due to the absorption of the soft rays by the tissues; the difference was especially apparent if the tail was of considerable thickness. 37 references.

1510 Experimental radio-necrosis of the brain in rabbits. Dorothy S. Russell, C. W. Wilson, and Katharine Tansley. *J. Neurol. Neurosurg. Psychiatry 12,* 187-95(1949) Aug.

Experiments on rabbits determining the effects of large doses of x-rays to the brain are described. For the first series, a single surface dose of 2,850 r was delivered in each case; the radiation was generated at 200 kv and filtered through 0.5 mm Cu and 1.0 mm Al at the surface dose-rate of 154.5 r/min, and at a focal distance of 25.5 cm. The subsequent series of animals received 2,440 r, 2,030 r, and 1,625 r, respectively. It was found that after the single radiation dose of 2,850 r, delayed radio-necrosis appeared in the rabbit about 100 days later; the latent period was lenghened by reducing the dose to 2,440 r. The initial histological changes consisted of minute foci of hemorrhage and necrosis which were intimately related to the perforating vessels, particularly capillaries; increased capillary permeability accompanied the lesion but was not present in the earlier, formative stages of lesion development. The lesions, when initiated, extended rapidly and progressed to the non-irradiated portions of the brain, and were characterized in the later stages by pronounced gliosis and progressive degeneration and sclerosis of the adjacent vessels. The neurones were only focally and secondarily affected; the meninges and their blood vessels were unaffected; the superficial parts of the cerebrum suffered no damage, although the cerebullar cortex was in some cases extensively damaged.

1511 Modification of the frequency of chromosomal rearrangements induced by x-rays in drosophila. IV. Post-treatment with near infrared radiation. Berwind P. Kaufmann and Katherine Wilson. *Genetics 34,* 425-36(1949) July.

Drosophila melanogaster males of the Swedish-b^6 stock were selected, three to five days before their emergence, and exposed to about 5,000 r of x-rays, using a Coolidge tube at 85 kv. They were then mated with virgin females and discarded; half of the females were subjected to ultraviolet radiations and the frequency of chromosomal rearrangements was determined. There was no increase in the frequency of the rearrangements due to the application of the ultraviolet rays after x-irradiation. A comparison between these results and those obtained in similar experiments is made and a theory is postulated. 28 references.

1512 On a new procedure for obtaining experimental intersexuality in the bird embryo. Eteinne Wolff and Berthe Salzgeber. *Compt. rend. soc. biol. 143,* 532-3(1949) Apr. (in French).

Chicken embryos 48-72 hr old were irradiated with x-rays for total exposures of 650-1,500 r for the purpose of determining the irradiation effects on the sex organs of these animals. The irradiation was either total body or selective exposure of the gonadal regions. One experimental series received a primary 1,100 r irradiation of the 26th to the 37th somites, followed 24 hr later by a total body exposure of 300 r. The experiments showed that the same definite intersexuality of the gonads and of the male genital tract occurs after irradiation as after the injection of feminizing hormones and ovarian grafts. The modifications are attributed to a disturbance of the natural hormone secretions.

BIOLOGY AND MEDICINE (continued)

1513 The production of dominant lethals with x-rays in aged drosophila melanogaster sperm. Øistein Strømnaes. *Genetics 34*, 462-74(1949) July.

Experiments to determine the effect of the age of the gametes at the time of x-ray treatment on the percentage of dominant lethals induced in Drosophila melangoaster sperm are presented. The dosages were delivered at 200 kv through 1 mm Al and 0.25 Cu filters at a distance of 31-41 cm and consisted of doses of 2,219-2,308 r; the sperm was aged 1-23 days. It was found that the sensitivity to x-rays increases with an increase in age; the age effect was also found when eggs were aged. No age effect was noted when the males were stored with the females; the age effect, moreover, was noted only in the sperms from early developing males. 15 references.

1514 Studies on the mechanism of action of ionizing radiations. IV. Effect of x-ray irradiation on the respiration of sea urchin sperm. E. S. Guzman Barron, Betty Gasvoda, and Veronica Flood. *Biol. Bull. 97*, 44-50(1949) Aug. (See also NSA 2-2097 and 3-957).

The results of studies on the sea urchin (Arbacia punctulata) sperm respiration rate at various sperm dilutions and after dosages of x-radiations are presented. The experimental procedures and the technique are described. X-ray dosages of 100-20,000 r were administered in separate experiments at a water dilution of 1:200 and with or without added succinate or acetate. The respiration of the sea urchin sperm increased with dilution up to a dilution of 1:200, where the average maximum value of 19.6 ± 3.9 was found. When the dilution was increased to 1:1,000 the respiration dropped sharply to 2.0, and a dilution of 1:1,600 gave no measurable respiration. When a dose of 20,000 r of x-radiations was delivered to the sperm solution an inhibition of 66% in the respiration was seen, which increased during the second hour; 10,000 r produced a 30% decrease; 1,000 r, a 22% decrease; 500 r, a 14% decrease; and, 100 r, a 10% decrease. It was found that when the sperm was irradiated with 1,000 r, there was no respiration recovery for 5 hr; on addition of succinate and of acetate to the solution, the oxygen uptake was further inhibited. 12 references.

1515 Radiation survey of x-ray output of an electron microscope from personnel hazard viewpoint. Louis B. Silverman, Sylvia B. Elliott, and M. A. Greenfield. AECU-384 (UCLA-37), July 26, 1949. 10p.

Results are presented of a radiation survey of a 50 kv electron microscope. Radiation levels from viewing ports were above tolerance. The hardness of the x-radiation corresponded to half value thicknesses of 1 to 2 mm of aluminum.

1516 Adenocarcinoma of the cervix and of the cervical stump. Bayard Carter, Walter L. Thomas, and Roy T. Parker. *Am. J. Obstet. Gynecol. 57*, 37-51(1949) Jan.

The results of the treatment by radiation therapy or surgery of 50 patients with adenocarcinoma of the cervix or cervical stump are reported. The surgical method consisted of a radical hysterectomy or a radical pelvic lymphadenectomy and removal of the cervical stump. The radiation therapy consisted of radium treatments for a total dosage of 3,600-6,300 r, vaginal cone applications for a total of 500-3,000 r or x-radiations of 8,604-13,600 r total dosage as the primary course; x-rays were also given post-operatively in total doses of 7,400-10,600 r. Thirteen persons, or 26%, are living and well; of these, six persons have survived five years or longer. 21 references.

1517 Cancer of the vulva. Émile Wallon. *Bull. asso. franc. étude cancer 36*, 117-21 (1949) (in French).

The results of the treatment of 46 cases of cancer of the vulva by radium puncture are presented. The usual radium dose was 665-3,225 mg-hr delivered by needles containing 400 mg-hr charges and given over a period fo 3-10 days. Radium surgery was rarely indicated. The total survival for four or more years was approximately 30% for all types of treatment. It is concluded that the radium puncture method employed was preferable to other methods because it allowed greater precision in dosage administration and the skin tolerance was higher.

BIOLOGY AND MEDICINE (continued)

1518 Concerning healthy offspring after radium-radiation of the male gonads. Juraj Körbler. *Radiologia Clin. 18*, 240-4(1949) July (in German).

A rare case is reported concerning a man who was irradiated with x-rays and with radium in order to cure a carcinoma of the rectum and who, after being sterilized for 10 years, gave evidence of being fertile. The radium administrations were introduced rectally and consisted of doses of 2,800, 1,761, and 960 mgh, with the gonads exposed; sterility followed after the complete cure of the carcinoma. The birth of a daughter to his family indicated the regeneration of the damaged gonadal tissue. It was found on examination that both the child and the father were normal in every respect.

1519 The control of polycythemia by marrow inhibition. A ten-year study on 172 patients. John H. Lawrence. *J. Am. Med. Assoc. 141*, 13-18(1949) Sept. 3.

The results of the treatment by sodium radio-phosphate of 116 patients with polycythemia are presented. It was found that the occasional administration of sodium phosphate containing P^{32} caused the localization of the P^{32} to a pronounced degree in the bone, bone marrow and rapidly growing tissue and kept the production of red blood cells at a normal or near normal level. In the entire group 85.6% of the patients had been previously treated by other means. After this therapy, spleen sizes and the number of immature white blood cells were markedly reduced; few thromboses occurred since the red cell mass, platelets and blood viscosity were brought to normal. A nearly normal life expectancy was obtained from these treatments, and the author concludes that with this method patients with polycythemia have favorable outlooks.

1520 Meeting reports. *Beihefte Z. Hals-, Nasen- Ohrenheilkunde 1*, 186(1948) Sept. (in German)

Among the papers presented at the meeting of the Society of West German Throat, Nose, and Ear Doctors which was held on the 4th of October, 1948, in Dusseldorf was the following: Concerning radium therapy of carcinoma of the vocal cords. Doses of 1,300-1,800 mg-hr were used in the treatment of this disease, delivered by 20 mg elements for periods of 87-100 hr. The tumors disappeared; with heavy irradiation (3,000 mg-hr) for shorter periods of time, loss of skin, and other radio-necrotic manifestations could be observed.

1521 A new beta-ray applicator using fission products. H. F. Freundlich. *Nature 164*, 308-10(1949) Aug. 20 (Letter to the editor).

The therapeutic uses of Ru^{106} and Ce^{144} are noted since these isotopes have the following fission-product chains, which consist of a long-lived parent emitting weak β rays and a short-lived daughter element emitting very strong β rays:

$$Ru^{106} \xrightarrow[290\ day]{\beta = 0.2\ Mev} Rh^{106} \xrightarrow[30\ sec]{4\ Mev} Pd^{106}\ (stable)$$

$$Ce^{144} \xrightarrow[275\ day]{\beta = 0.35\ Mev} Pr^{144} \xrightarrow[17\ min]{3\ Mev} Nd^{144}\ (stable)$$

Both elements when in equilibrium with their daughter elements represent very powerful β emitters with a long half-live, and as such are particularly suitable for use in radiotherapy applicators. Using an experimental arrangement which is shown, by means of which the emitted particles may be collimated and then scattered by thin foils, a reasonably uniform field can be obtained over a depth of 3-4 mm by the use of β rays from fission products.

1522 On the close irradiation of operatively exposed tumors of the antrum of Highmore. Josef Beck and Gunther Barth. *Arch. Ohren- Nasen- Kehlkopfheilkunde 155*, 396-404(1949) Mar. (in German).

Close irradiation, or irradiation by the method of Chaoul was used in the treatment of the cases of tumors of the antrum of Highmore which are discussed here. The method consists of the irradiation of the tumor area with large doses until the tumor disappears, and the protection of the healthy tissue around the tumor area. The usual daily doses were 500-600 r, until 6,000-12,000 r was given; in cases of recurrence further irradiation was administered. The radiations were delivered at 100-120 kv through a filtration of 3 mm Al at a target distance of 30 cm and through target tubes which allowed exact application of the rays to the exposed area, and protection of the healthy tissue. The details of five cases are included. Good results were obtained with this method.

BIOLOGY AND MEDICINE (continued)

1523 Proceedings of the French-speaking congress of medical electro-radiologists. *J. Radio. Electro. 30*, 263-370(1949) (in French).

Among the papers presented at the meeting on July 27 and 31, 1949, of the sixth congress of medical electro-radiologists held at Geneva, Switzerland, were the following: Mutations and radiations, Emilé Guyénot; The role of radiations in the treatment of cancer of the breast, J. Maisin; Orthokinetic radiotherapy. Technique of choice for systematic improvement following the vertebral-spinal axis, P. Jacob; Concerning the initial effect of x-rays on the epithelial cells, W. Jadassohn, E. Bujard, R. Paillard and P. Gaudin; The problem of dosages of radioactive isotopes in therapeutic applications, G. Joyet; The treatment of tumors of the recto-sigmoid villi by contact radiotherapy, H. Ramioul and R. Crismer; Roentgen-therapy alone employed for the treatment of cancer of the breast, operable or inoperable, M. Baclesse; Radiotherapeutic ballistics in cancer of the breast without metastases, G. Daniel; Contribution for pre-operative radiotherapy of cancer of the breast, Paul Gibert; Bilateral mammary cancer, P. Desaive; Radiotherapy of the skeleton in diabetes insipidus and lipoidal nephrosis, Pietro Cignolini.

1524 Radiotherapy for Parkinson's disease. J. P. May and R. Adam. *Semaine Hopitaux Paris 25*, 2330-3(1949) July 22 (in French).

The results of the treatment of 12 cases of four types of Parkinson's disease with radiotherapy are presented. The treatment consisted of 50 r per session, usually twice a week; the doses were increased up to 150 r if the patient's tolerance was good. The total dosage which was allowable for two or three fields was 2,400-3,000 r; the authors used 1,000 r per field as the standard. The results show that this type of therapy produces a lasting amelioration of the muscular hypertonus and of the fixed attitudes; it has a clearly sedative action on the diencephalic disturbances, but cannot be applied to all cases, since deep lesions of the encephalon may occur. 10 references.

1525 Radium treatment of cancer of the rectum. Franciszek Lukaszczyk. *Polski Tygodnik Lekarski 4*, 513-15(1949) May 2 (in Polish).

The results of 11 cases of cancer of the rectum which were treated by applications of radium tubes containing 6.6-13.3 mg of radium with a 2 mm platinum filter are presented. The cancers were of the early, low situated type and were given uniform irradiation which permitted complete regression, lasting 3-7 years, in six cases; both adenocarcinomas and squamous cell carcinomas were treated. Post irradiation reactions such as tenesmus and pain lasted several weeks and were rather mild. The author concludes that the only really radio-resistant carcinomas are the gelatinous forms.

1526 Roentgen therapy of the epileptic syndrome. A. Toti. *Rev. Patologia Nervosa Mentale 69*, 503-510(1948) (in Italian).

A report is presented on the results of the treatment of 51 cases of the epileptic syndrome with roentgen therapy. The x-ray therapy consisted generally of irradiation from a 180-kv source through 0.5 Cu and 0.5 Al filters, at a focal distance of 30 cm, to four cranial sites (one frontal, two parietal, and one occipital); there were eight treatments to a cycle, with a total dose of 800 r, and one or two cycles was the standard procedure. Of the 51 cases treated by this method and observed over a period of three years, 18 (35.2%) demonstrated no epileptic manifestations after the treatments, 16 (31.3%) were clearly improved, while 17 cases (33.3%) remained unchanged. It was shown that cases when treated early yielded the best results (62.5% cured) as compared with cases in later stages (14.8% cured); cerebropathy and hydrocephaly cases yielded most readily to the treatment. 13 references.

1527 Skin cancer: a ten-year survey in private practice. J. G. Thompson. *Southern Med. J. 42*, 805-8(1949) Sept.

The results of the treatment of 3,331 cases of squamous cell and basal cell carcinoma by: (1) desiccation, curettage, and radium, (2) radium only, (3) x-rays only, (4) and desiccation, curettage, and x-rays are presented. Topical applications of 5 mg platinum-irridium-radium needles were used, and x-ray dosages up to 1,600 r at 8-in. focal distance and 80-120 kv with either 1 mm Al filters or none were delivered in some cases. The desiccation, curettage, and radium method yielded a 0.93% recurrence rate; the radium only method showed 5.03 recurrences; the x-ray method showed 6.66% recurrences; and the desiccation, curettage, and x-ray method gave a recurrence rate of 3.8%. Recurrences in 711 keratosis cases treated by dessication and curettage were negligible. In conclusion, the author favors irradiation by x-rays as the treatment of choice.

BIOLOGY AND MEDICINE (continued)

1528 The treatment of cancer of the larynx with roentgen radiations through fenestrated thyroid cartilage. E. Ruckensteiner and L. Horbst. *Krebsarzt 4*, 191-6(1949) June (in German).

A review of the literature is presented and the results from 15 cases of cancer of the larynx which were treated by roentgen radiations are discussed. The x-radiations were of the contact therapy type and were usually 8,000-10,000 r for each of several fields. If the area contained a recurrent tumor, then 12,000-15,000 r total dosage for each of several fields was given; and if the area had been previously irradiated, then up to 18,500 r for each of two fields was delivered. Of the 15 cases treated in this manner, 6 have become so improved that they present clinically a negative finding for carcinoma. The other cases show degrees of improvement or recurrence of the disease.

1529 Treatment of epithelioma of the neck of the uterus. J. Baud. *Bull. asso. franc. étude cancer 36*, 80-7(1949) (in French).

The results of the treatment of 1,430 cases of epithelioma of the uterine neck by intravaginal curie therapy, roentgen therapy, telecurietherapy, and combined intracavitary curie therapy and peripelvic x-ray therapy are presented; a general description is given of each type of therapy. The five-year results on 858 patients shows that an average of 45% for all the therapeutic methods were living and well; 35.4% were living and well after 10 years; and 24.4% were living and well after 15 years. The results are tabulated according to the type of therapy used.

1530 Treatment of epitheliomas of the vulva. J. Baud. *Bull. asso. franc. etude cancer 36*, 104-116(1949) (in French).

The results of 63 cases of epithelioma of the vulva are presented and the treatment by radiations is described. Radium punctures, radium vulva molds, telecurie therapy, and roentgen therapy were the methods used. The radium puncture method consisted of the total administration of 931-4,788 mg-hr; radium vulva mold method gave a total dose of 1,463-6,650 mg-hr; the roentgen therapy consisted of the irradiation of two or more fields as did the telecurie therapy. Two patients have remained cured for 13 and 17 years, respectively, and the various treatments have allowed a total of nine patients cancer-free lives for at least five years. The complications from the use of these methods were many, consisting of very painful local reactions slow to repair themselves, sclerosis and necrotic radio-ulcerations, and other complications such as constrictions of the anal canal. It is concluded that a large number of local relapses were occasioned by the severe reactions from the radiations and the inability to eliminate by irradiation those chronic vulvular lesions which eventually become malignant.

1531 Trial of a technique of contact-radiotherapy of cancers of the larynx. Jean Terracol and Paul Lamarque. *J. Radiol. Electrol. 30*, 140-2(1949) (in French).

Seven patients with cancer of the larynx were treated by the contact radiotherapy method employing a 54-kv source with a dose rate of 2,250 r/min; the dose time was usually 1½ min for each irradiation. Generally four irradiations were given, the total dose being approximately 13,500 r; the treatment was distributed over a 15-day period. The advantages of this method of therapy are discussed and correlated with the early satisfactory results on the seven patients.

1532 Urethane and its association with radiotherapy in human leukemias. P. Dustin, Jr. *Rev. belge path. et med.exptl. 19*,115-174(1949) Mar. (in French).

Radiotherapy is discussed in connection with the urethane treatment of various leukemias. The x-radiation dosages used were generally about 100-300 r, and were administered over long periods of time; urethane was always given when radiotherapy was used. Radioresistant and urethane-resistant leukemias are discussed. From the 26 cases of chronic myelogenous, chronic lymphatic, and acute monocytic leukemias presented it was seen that the best results were obtained in the chronic myelogenous leukemia cases; the urethane decreased the number of leucocytes while the red blood cells increased, and the general condition improved; doubtful effects were obtained from the treatment of the other types of leukemia. The data suggest that urethane acts like irradiation, in that it selectively poisons leukemic cells by disturbing their mitosis. Further research on urethane is recommended. 100 references.

BIOLOGY AND MEDICINE (continued)

1533 The use of irradiation, surgery and hormones in breast cancer. Frank E. Adair. *Proc. Roy. Soc. Med. 42*, 468-74(1949) July.

The results of 3,988 cases of breast cancer are presented, and the methods of treatment which were employed are outlined. X-ray therapy alone was used in the treatment of 125 operable cases and consisted of delivering a total of 3,000 r to each of five portals through fractionated doses with a 250-kv machine. It was found that with radio-resistant lesions it was necessary to irradiate with about 5,000-6,000 r for each portal; this high total dosage could not be given without the danger of involving the underlying bones, and producing damage to the skin and lungs as well. The five-year cure rate for the cases treated by irradiation alone was 26%, as compared with 50% for the cases treated by pre-operative irradiation and surgery. The pre-operative irradiation procedure consisted of x-ray doses of 1,200-3,600 r for each portal, but it was found that a delay was usually necessary in performing the surgery because of the reactions to the radiations. The statistics demonstrated that the combination of x-radiations and radical surgery produced worse results than immediate surgery alone. The results with radical surgery and post-operative x-ray therapy are about 7-8% better than the pre-operative irradiation and surgery; the results of hormone therapy in connection with radical surgery are also discussed.

CHEMISTRY

1534 Observations on the 8-hydroxyquinoline and related derivatives of gallium, indium, and thallium. Therald Moeller and Alvin Jerome Cohen. University of Illinois. Aug. 15, 1949. 56p. (NP-1011).

In the present investigation, the oxinates of gallium, indium and thallium, the dibromoxinates of gallium and aluminum, and the dichloroxinate of gallium have been studied. Special emphasis has been placed on spectrophotometric investigations of chloroform solutions of these compounds. This work was undertaken to show relationships and trends in the III B family. The effect that substituent groups placed on the quinoline nucleus have on the absorption spectra of the complexes has been investigated. In order to evaluate properly the absorption spectra of these chelate compounds, the absorption spectra of quinoline, oxine, dichloroxine, and dibromoxine in chloroform have also been observed and compared with those of the corresponding metal derivative. The effects of substituting, a hydroxy group in the 8 position, and, a hydroxy group in the 8 position plus chloride or bromide in the 5 and 7 positions, on the absorption spectrum of the quinoline nucleus have been determined. Trends in the family were observed with respect to the pH of oxinate precipitation, pH range of maximum extraction by oxine in chloroform, wavelengths and molecular extinctions of the absorption peaks, stability of the oxinates in chloroform solution, adherence to Beer's Law, and applicability of the compounds to analytical practice. 42 references.

1535 On the stability of some organic complexes of the elements of the fourth and fifth groups of the periodic system. I. Oxalates, citrates, and tartrates of Ti, Zr and Th. M. Haissinsky and Yang Jeng-Tsong. *Analyt. Chim. Acta 3*, 422-7(1949) July (in French).

The values of the pH of precipitation of the oxalates and citrates of Ti, Zr, and Th by caustic soda or ammonia as a function of the concentration of the anion have been determined. At a concentration of the metal of about 7 millimol/l the tartrates are not precipitated by these two reagents. The order of stability of the complexes is as follows: tartrates > citrates > oxalates; Th > Zr > Ti.

1536 The vapor pressure of HCl-HBr solutions at −86.4°C. David Altman. AECD-2681, June 19, 1945. Decl. Aug. 26, 1949. 10p.

A method for analyzing the composition of a mixture of gaseous HCl and HBr is presented. The process is based on solidifying the gas by freezing out with liquid air and measurement of the vapor pressure as the solid mixture is melted in trichloroethylene freezing slush. At the melting point of trichloroethylene which is −86.4°C, both HCl and HBr are liquids, the vapor pressures being 700 mm and 250 mm, respectively. Each mol % corresponds, therefore, to approximately a change of $\frac{700 - 250}{100} = 4.5$ mm vapor pressure of solution, which can be read with ease on a mercury manometer. The dry gases presented no corrosion difficulties on mercury. The apparatus used is shown. HCl was let into an evacuated vessel through a stopcock and the pressure was then measured on a manometer. HBr was then let in and the pressure increase noted. The mol fraction of HCl was calculated from the formula $N_{HCl} = \frac{P_{HCl}}{P_{HCl} + P_{HBr}}$.

CHEMISTRY (continued)

1537 Procedure for the radiochemical analysis of barium, strontium, and the rare earths in human urine. Paul C. Tompkins, L. B. Farabee, and J. X. Khym. AECD-2692, Aug. 10, 1949. Decl. Aug. 26, 1949. 17 p.

A procedure for the simultaneous analysis of radioactive Ba, Sr, and rare earths in human urine has been developed. The method consists of an alkaline phosphate precipitation from a 24-hr urine sample, separation of the phosphate from the cations by means of an ion exchange resin, and separation of Ba and Sr along with their La and Y radioactive daughters from Ca and Mg by the precipitation of Sr chromate from an alkaline solution. The procedure is essentially quantitative for La and Y provided no significant mechanical loss of a precipitate occurs. The recovery for Ba was found to be around 95%, while that for Sr was around 90%. These losses were found primarily in the filtrate from the Sr chromate precipitate.

1538 Rapid radiometric assay for radium, and application to uranium ore process solutions. D. P. Ames, J. Sedlet, H. H. Anderson, and T. P. Kohman. AECD-2696, nd. Decl. Sept. 1, 1949. 27p.

A rapid method of assay for radium in solution based on the precipitation of radium with barium as carrier and counting of its α particles, is described. In sulfate-free solutions $(Ba,Ra)Cl_2$ is precipitated with concentrated hydrochloric acid and ether. In sulfate-containing solutions $(Pb,Ra)SO_4$ is first precipitated, followed by a $(Ba,Ra)Cl_2$ precipitation. The chloride is converted to the sulfate on a Pyrex disc for counting α particle in a parallel-plate ionization chamber. The method is general for all α-emitting radium isotopes and is sensitive to 10^{-12} gm Ra^{226} and is accurate to 3-10%. It separates radium from all other α-emitting substances accompanying it in nature. Applications to uranium ore process solutions are described. The method is found suitable for certain control problems in which knowledge of approximate radium concentrations is required in 30-60 min. In this application the sensitivity is limited by interfering activities to 10^{-10} gm Ra/ml.

1539 The separation of beryllium, aluminum, uranium, and vanadium by cupferron in systematic qualitative analysis. E. Bishop and A. B. Crawford. *Analyst 74*, 364-5 (1949) June (note).

A method of using cupferron to separate berylluim, aluminum, uranium, and vanadium from a residue containing $Al(OH)_3$, $Be(OH)_2$, $(UO_2)_3(VO_4)_2$, $AlVO_4$, and uranium is described. This process has been tested on the macro, semi-micro, and micro scales by proportional alteration of quantities and found satisfactory in all combinations of ions.

1540 Chemical action on organic iodides of various radiations and their subsequent quantitative determination from the quantity of iodine liberated. Pierre Süe and Einar Saeland. *Bull. soc. chim. France*, Nos. 5-6, 437-9(1949) May-June (in French).

Several iodides (ethyl, propyl, butyl, etc.) very sensitive to the photochemical action of light, are also decomposed by various radiations such as d, α, x, γ, and n. Under this action the molecule is destroyed, the liberated iodine remaining in the solution, where it is determined by photocolorimetry. This type of radiochemical reaction appears more simple than those requiring aqueous solutions where two processes are necessary, because an activation of the water must precede the reaction. It was observed that, for small quantities of iodine, the iodine liberated is proportional to the quantity of radiation and varies only slightly for the various iodides studied. The iodine liberated permits a determination of the radiation doses and a comparison between them. The effect being additive, an iodide which has already been used can be employed again; this permits, if necessary, cumulative measurements. Dilute ether solutions of ethyl iodide show also a remarkable proportionality between the quantity of liberated iodine and the duration of the irradiation. The dosage of wide beams could thus be effected with reasonable quantities of iodides. Although the density of the latter solution is equal to unity, and its hydrogen content is close to that of water, it remains to be shown, for radiation dosages in biology, that the absorptions observed are similar to those in tissues.

1541 The possibility of enhanced Hg^{202} as a source of monochromatic light. J. R. McNally, Jr., P. M. Griffin, and L. E. Burkhart. AECU-386, July 18, 1949. 8p.

Electromagnetically enhanced Hg^{202}, as a source material for highly monochromatic radiation, is discussed briefly with relation to the effects of the isotopic impurities. A Fabry-Perot interferogram showing line purity in the 98.06% Hg^{202} is reproduced. The present status of the mercury enhancement indicates that Hg^{202} may be separated from the natural species in sufficient quantity and in sufficient purity to produce lamps having a monochromatic and reproducible wavelength, namely, the 5461 A line.

CHEMISTRY (continued)

1542 On the fluorescence of europium.. Karl Przibram. *Acta Phys. Aust.* 3, 126-9(1949) June. (in German).

The position of band maxima of fluorescence spectra of bivalent europium was determined in preparations in which traces of europium were present in various materials, such as NaCl, $CaCl_2$, $Na_2B_4O_7$, and others. The excitation was obtained in ultraviolet light. The position of the maxima depends on the heat treatment of the preparation: temperature, nature of the flame and of the support (glass, platinum). The results are presented in a table.

1543 On the electrolytic polishing of uranium in the light of physico-chemical and metallographical studies. Pierre-A. Jacquet and Roger Caillat. *Compt. rend 228*, 1224-6 (1949) Apr. 4 (in French).

The fact that electrolytic polishing produces a well-defined state of the metal surface has been applied to micrographic examinations and to the study of the formation of uranium hydride. The following reaction takes place following electrolytic polishing of uranium: $U + \frac{3}{2}H_2 \rightarrow UH_3$ (about 220°) which was found useful. It assured easy and effective cleaning of the specimen, removing the oxide layer from the metal.

1544 Solubility of uranyl nitrate hexahydrate and thorium nitrate tetrahydrate in organic solvents at 20°C. L. Yaffe. *Can. J. Research 27 B*, 638-45(1949) July..

A study has been made of the solubility of uranyl nitrate hexahydrate and thorium nitrate tetrahydrate in various organic solvents at 20°C. In all the solvents investigated no case was found where the thorium nitrate tetrahydrate was more soluble than the uranyl nitrate hexahydrate. Hydrocarbons do not dissolve either compound to an appreciable extent. Addition of a ketone, aldehyde, or alcohol group enhances the solubility considerably. The simpler the compound the greater the solubility of the nitrate in any given family.

ENGINEERING

1545 A rectangular diffusion pump. K. M. Simpson. AECD-2687, Sept. 13, 1945. Decl. Aug. 25, 1949. 10p.

A diffusion pump having a rectangular mouth 1 ft by 3 ft in the vertical plane, employing linear jets, was constructed and improved so that its capacity was about 7000 l/sec and so that it could, from a cold start, be pumping in 20 min and be cooled enough to open to atmosphere in 10 min or less.

1546 Effect of thermal lagging on an 8-inch diffusion booster pump. Kenneth M. Simpson and William M. Bush. AECD-2688, Jan. 25, 1945. Decl. Aug. 26, 1949. 6p.

Tests have been conducted concerning the effects of the feasibility of thermally insulating the boiler of 8-inch booster pumps of the design in present use. As a result of these tests the following conclusions and recommendations are drawn: (1) the use of thermal insulation around the boiler will greatly increase the fore-pressure tolerance of the pump and the resultant reduction in speed will be unimportant; (2) increasing the power input to 2500 watts will also add about 50 μ to the fore-pressure tolerance; (3) the oil will apparently not be damaged by the changes herein suggested.

1547 Life tests of tungsten and tantalum filaments in ion gauges. W. E. Bush. AECD-2682, Jan. 8, 1944. Decl. Aug. 26, 1949. 19p.

Results indicate that for the concentrations of air and water vapor tried, there is no advantage to be gained in operating tungsten filaments at excessively low emissions in order to reduce the temperature. This seems likely for tantalum also. In the case of tungsten, the wattage required for a given emission is a linear function of the time of operation, and the ratio of the final to the initial power is the same as the ratio of the final to the initial diameters of the filaments. Tapering of tungsten filaments at usual emission values is negligible. The life of a tungsten filament is proportional to the initial diameter. No great changes (more than 10%) of calibration were noted during the life of any filament excepting in tantalum a few minutes before burnout. As is already known, filament disintegration is somewhat proportional to the concentration of either air or water, the water being more effective. This seems to be true of tantalum as well as tungsten. Tantalum filaments of size equal to tungsten filaments can be expected to have from 5 to 10% the life of tungsten in the same atmosphere of air and water.

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1548 A retractable liquid air trap. Alan J. Samuel. AECD-2684, Nov. 11, 1943 Decl. Aug. 25, 1949. 9p.

The ordinary design of liquid air trap does not permit its removal from the vacuum system without first letting the system down to air. Because of this fact, after the trap surface had collected condensed vapors it would be impossible to let the trap go without liquid air; otherwise the condensed vapor would evaporate and raise the pressure in the system. The primary purpose of a retractable liquid air trap is to isolate the trap from the main vacuum chamber after an optimum pressure is obtained, thus making it possible to cease using liquid air for the remainder of the run. An experimental trap is described in detail. Retraction of the trap from the manifold system is accomplished by raising the trap as far as it will go. As the trap is raised it pulls a circular plate which hangs from underneath the trap, up against a rubber gasket, thus isolating the trap from the manifold sytem. A valve, in the line leading from the upper trap housing to the fore-vac pump is then opened so that the condensed vapor on the trap can be pumped out as it evaporates. Any liquid air that is in the trap when it is retracted may be removed and salvaged by means of air pressure.

1549 "Grooveless flange-gaskets" and their installation. Alan J. Samuel. AECD-2685, July 26, 1944. Decl. Aug. 25, 1949. 14p.

The grooveless flange-gaskets described were designed to be used with 2 in., 3 in., 4 in., and 6 in. standard ASA 150# forged steel welding neck flanges, respectively, having a 1/16 in. high serrated face. Drawings show the details of a pump-out hole in the 2 in., 3 in., 4 in., and 6 in. ASA 150# forged steel welding neck flange (making it possible to check the inner gasket for vacuum tightness), which has been designed for use with the above mentioned flange-gaskets. Molds for the 2 in., 3 in., and 6 in. size are shown. Spacers have been placed between the inner and outer gaskets on both sides of the sheet steel body to permit a maximum of 25% decrease of the original thickness of the gasket upon compression. This 25% amounted to 1/16 in. in all sizes. Holes have been placed in the sheet steel body between the inner and outer gasket to connect the pump-out space on either side of the sheet steel body so that it was only necessary to have a pump-out hole in one of the flanges at each joint. Good contact of the rubber to the steel body is assured during the molding process by sand blasting the steel all over before molding and by the numerous holes in the body directly beneath the rubber, so that the rubber on either side of the body holds itself together. The Hycar formula No. 1H 9151 rubber was used, with a specified durometer hardness of 58-60. The serrations on the faces of the flanges prevent the gasket from squeezing out as easily as it would on a smooth surface. Specific applications of the joints to uses with vacuum systems have been made.

1550 Philips type vacuum gauge. K. M. Simpson.. AECD-2689, Jan. 7, 1944. Decl. Aug. 26, 1949. 10p.

The Philips gauge consists of a double plate cathode and a single ring anode placed between the cathode plates, the whole being oriented in a magnetic field. The electrical connections are shown. The effect of the geometry and the magnetic field is to make it possible to strike and maintain a glow discharge at a much lower pressure than is usually the case. Electrons in the space between the cathodes are accelerated, during the time when the ring is positive, toward the ring. The magnetic field, however, prevents most of the electrons from actually reaching the anode. An electron which starts from above, say, the anode ring, is thus shot through the ring toward the other cathode plate. Once past the plate it is brought to rest by the opposing electric field and accelerated upwards. This oscillatory motion continues for some time. Presumably it is ended by the electron finally making its way to the ring. The result is a very much lengthened path for the electrons. Their paths being longer they have more chance than in the usual discharge tube to ionize a gas molecule. The positive ions formed proceed under the influence of the electric field to the cathodes. In bombarding the cathodes, they produce secondary electrons which enter into the maintenance of the discharge. It is found that the discharge current is a good measure of the pressure in the vessel. The range of the gauge is from about 0.1 or 0.2×10^{-4} mm Hg to about 10 or 15×10^{-4} mm. Variations with respect to materials, voltage, and the magnetic field are discussed. Information on safety, leakage, sensitivity possible, quickness of response to changes of pressure, use for leak hunting, and calibration is included.

ENGINEERING (continued)

1551 Report on d-c operation of Philips gauges. J. R. Tolmie and K. M. Simpson. AECD-2690, May 3, 1944. Decl. Aug. 26, 1949. 10p.

A discussion of the capabilities and limitations of the a-c and d-c operation of the gauges is given. Proposals for overcoming some of the undesirable characteristics are made. A circuit for providing a regulated source of d-c power is shown. Various leakage paths that may introduce spurious currents into the microammeter branch of the circuit are shown. An arrangement employing a double bushing and shield is proposed which is designed to eliminate the leakage. It is suggested that future designs should be based upon the use of larger port hole openings in the tank wall for better mechanical and electrical arrangement of the component parts of the gauge.

1552 Calibration of Philips ion gauge. J. R. Tolmie. AECD-2691, Mar. 25, 1944. Decl. Aug. 25, 1949. 12p.

This report accompanies a set of calibration curves of the standard gauge. The calibration data shown on accompanying charts was obtained by employing an experimental layout indicated in a schematic drawing. Both of the Philips ion gauges used were of the conventional type. These gauges are comprised of a 1 in. diameter ring type of anode, which is located coplanar with and midway between two 2-1/2 in. square copper cathodes, which are separated by an interval of 1/2 in. The D.P.I. triode type of ionization gauge, which was employed during the tests was in turn very carefully calibrated against a number of D.P.I. and Western Electric Company ionization gauges. In the pressure range of 0.2×10^{-4} to 5×10^{-4} mm of Hg, the glow discharge current of the Philips gauge is a substantially linear function of the pressure. Above this range, namely in the region of 5×10^{-4} to 20×10^{-4}, an appreciable curvature becomes manifest. This curvature is not enough to be serious where only moderate accuracy is desired. These relations are shown. Good correlation was obtained with the data which was taken on successive days of the test. This is interpreted as an indication of the stability of the gauge. Charts also give a comparison between two ordinary shop models of Philips ion gauges. Taken one against the other, these gauges show an excellent linear response.

1553 Hot-wire vacuum switch. Clarence W. Wieske. AECD-2693, Nov. 18, 1943. Decl. Aug. 25, 1949. 11p.

The development of an electric switch which will open an interlock circuit within a fraction of one second if the gas pressure in a vacuum system should rise above a predetermined level is described. The switch can be used on either the high-vacuum or fore-vacuum side of a system. The cut-off point can be from 10 to more than 400 μ. Photographs and a schematic drawing are shown.

1554 Improved hot-wire vacuum switch. Clarence W. Wieske. AECD-2694, Sept. 6, 1945. Decl. Aug. 25, 1949. 11p.

This report summarizes changes and improvements made on the hot-wire vacuum switch since the original report, vacuum special No. 15 (AECD-2693). An improved panel, incorporation of an external resistance box, and addition of a decade box with 10-ohm steps, to plug directly into the interlock panel, are described.

1555 On the characteristics of Philips type ion gauges. Louis F. Wouters. AECD-2695, Jan. 8, 1944. Decl. Aug. 26, 1949. 25p.

The gauge consists of two flat parallel plates, serving as cathodes, mounted opposite each other, with a circular loop of wire, an anode, lying in a plane parallel to and halfway in between the two outside plates, the whole configuration being oriented so that the elements are substantially normal to the magnetic field. Electrically the two outer plates or cathodes are essentially tied together and grounded while the ring or anode is hooked through a stabilizing resistor to one end of the secondary winding of a high (2000 v) voltage transformer, the other end of the secondary winding being connected through a d-c microammeter to ground. This device makes use of the oscillating electron current (for the production of positive ions from gas molecules present in a vacuum system) which can be set up in any geometry having a positive electrode (in this case a loop of wire) within two negative ones (two large plates), the entire configuration being sensibly perpendicular to a magnetic field. The ions are collected on the plates at a rate determined by the rate of ion production, which in turn is dependent on the gas pressure. The sheathes at the electrodes adjust themselves to permit equal electron current to the anode ring and to the plate cathodes, under static conditions. Since, when maintaining a constant supply voltage, the collected current vs gas pressure characteristic is a rising one, a large series resistance is inserted to stabilize the circuit and make it more linear. Also, since the geometry passes current in only one direction, it is possible to apply a-c directly to the electrodes. Supplemental information on a high voltage transformer and heating of the insulator by electron bombardment is included.

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1556 A precision vacuum gauge. G. C. Fryburg and J. H. Simons. *Rev. Sci. Instruments 20*, 541-8(1949) Aug.

A pressure measuring device of the general type first described by Knudsen has been constructed for obtaining precision measurements of gaseous pressures in the range from 1×10^{-5} to 10^{-3} mm of Hg. The instrument has been calibrated, with the aid of a McLeod gauge, in nitrogen, hydrogen, oxygen, methane, ethylene, n-butane, and iso-butane. The mechanical precision of the instrument seems to be better than ± 0.5% and the accuracy of the above calibrations is probably of the order of ± 1%. Calibration curves for the above gases have been treated analytically and equations for the different gases have been discussed. An empirical method of calibration has been described for calibrating the instrument in condensible gases whose pressures cannot be measured in a McLeod gauge.

MINERALOGY, METALLURGY AND CERAMICS

1557 The alloy systems uranium-aluminum and uranium-iron. Paul Gordon and A. R. Kaufmann. AECD-2683, nd. Decl. Aug. 26, 1949. 42p.

Melting of alloys is described, and scaled drawings of an induction melting furnace used are presented. Heat treatment of specimens and thermal measurements with a scaled diagram of the apparatus used are described. U-Al and U-Fe equilibrium diagrams, photographs of microstructures, x-ray diffraction studies, and some physical properties of the alloys are given.

1558 The alloy systems uranium-tungsten, uranium-tantalum and tungsten-tantalum. C. H. Schramm, P. Gordon, and A. R. Kaufmann. AECD-2686, nd. Decl. Aug. 26, 1949. 39p.

The U-W and U-Ta alloy systems have been found to contain in each case only five phases (neglecting the gas phase), the high temperature liquid solution of the two metals involved, and the solid phases α, β, and γ U plus either W or Ta. No intermediate phases were detected in either system. The temperatures of the α-β and β-γ U transformations have been located at 670 and 770°C, respectively, in the U-W system, and 680 and 760°C, respectively in the U-Ta system. The solidus transformations have been described as of the peritectic types in both systems, occurring at 1135°C in the U-W system, and at 1175°C in the U-Ta system. The order of magnitude of the terminal solid solubilities for both systems has been shown to be small. The liquid solubilities of W in U up to 2400°C and of Ta in U up to 2000°C have been reported. Two phases of the U-Ta-C ternary system have been discovered; one approximating the formula $UTa_{10}C_4$, having a low crystal symmetry and an extremely high melting point, and the other being a face-centered cubic phase with $a_o = 4.41$A. The Ta-W system has been indicated to be a continuous series of solid solutions. The relationship between lattice parameter and composition for the Ta-W solid solutions has been determined.

1559 Report on tungsten. E. L. Reed. AECD-2700, Sept. 15, 1947. Decl. Sept. 7, 1949. 107p.

Tungsten is given as the 38th element in the order of abundance in the earth's crust, its occurrence virtually always associated with igneous rocks, especially granites and acid pegmatites. In this respect it differs from most other minerals. The chief ores of tungsten are scheelite and wolframite. It is interesting to note that practically all of such ores are mined in countries bordering the Pacific Ocean; China and Burma being the outstanding producers. The preparation of tungsten metal involves treating selected ores chemically to produce purified tungstic oxide. The tungstic oxide particle size must be carefully controlled in order to produce metal powders having a characteristic particle size range vitally important to producing a pressed and sintered rod which may be swaged and fabricated successfully. The purity of the final tungstic oxide must also be especially good as only a few hundredths of a percent of certain impurities render the final product worthless for swaging and fabrication. Since metallic tungsten has a very high melting point, (6170°F), powder metallurgical techniques must ordinarily be used in order to prepare tungsten in a massive form for fabrication. The complete operation is characterized by the necessity of controlling purity, particle size, temperature, and technique to a very fine degree. Property and fabrication data, preparation, analysis, equilibrium studies with other elements and compounds, effect of radiation, and nuclear data are included. 110 references.

1560 A note on the preparation of uniform metallic foils. S. D. Warshaw. *Rev. Sci. Instruments 20*, 623(1949) Aug. (Laboratory and shop note).

A method is described for the preparation (from a variety of metals) of uniform foils of reasonably known thickness, free of wrinkles and pinholes. Carefully cleaned glass slides were first coated with a weakly adherent plastic film by immersion in a 5% solution of pyroxylin in a 50%

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mixture of ether and alcohol; the slide was withdrawn in such a way that the excess liquid could drain off. The coated slide was then placed in a vacuum evaporator and covered with metal. After evaporation, the edges of the film on the glass were roughed with a sharp knife, and the film cut across at about 2 cm intervals. The slide was then immersed at about a 45° angle to the surface of a dish of distilled water. The surface tension of the water was usually enough to peel the plastic film off the glass, carrying the foil with it, and leaving the foil and backing floating on the water surface. For mounting the foils, it was convenient to use a small brass frame, about 1.5 x 2 cm, with a 2 mm wall. This was placed under the floating foil and raised carefully so that the surface tension would not cause any rupture. The last few wrinkles were removed with the aid of a soft brush dipped in alcohol and the foil then washed free of the plastic by dipping it, mounted on the frame, into the ether alcohol, at right angles to the liquid surface. The method has been used for the preparation of Al, Cu, Au, and Ag foils, with thicknesses ranging from 0.04 to 0.3 mg/cm^2 in the case of Al, and from 0.1 to 0.4 mg/cm^2 for the heavier metals.

1561 A two-dimensional model illustrating the effect of thermal agitation during the deformation of metallic solids. Roscoe H. Woolley and Dan McLachlan, Jr. University of Utah Technical Report VI. Feb. 10, 1948. 33p. (NP-882).

A method has been described for producing a motion picture story of metallic atoms in motion caused by thermal agitation while in the gaseous, liquid, and solid states; also, the action of atoms is portrayed during the deformation of a solid and during the growth of crystals. An illustration is given to indicate that the method is not restricted to the representation of metals only. Since the simulated molecular actions were to take place in two dimensions only, it was found that the desired results could be obtained by letting small metal spheres or shot represent the atoms. Also the effect of thermal agitation could be imitated by mechanical vibrations produced by a small electric motor. To confine the spheres to two dimensions, a single layer of them were contained between two sheets of glass.

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1562 On the knock-on secondaries of penetrating particles. W. W. Brown, A. S. McKay, and E. D. Palmatier. *Phys. Rev. 76*, 506-510(1949) Aug. 15.

The knock-on secondaries of penetrating particles emerging from lead plates (15 g cm^{-2}) have been investigated by means of a cloud chamber and also by means of a counter telescope. The frequency of occurrence and the observed spatial distribution of the secondaries with respect to the primary penetrating particles have been found to be in agreement for the two different methods. Further data are presented on the back scattering of secondaries in lead plates and on the emergence of secondaries from thin pieces of wood and counter walls. The possible effects on counter experiments are discussed briefly.

1563 Latitude dependence at 30,000 feet of penetrating particles slowed down after traversing 15 cm of lead. Marcello Conversi. *Phys. Rev. 76*, 444-5(1949) Aug. 1. (Letter to the editor) (See also NSA 3-1257).

The results obtained using delayed coincidence counters in B-29 flights at 30,000 ft are tabulated for the composition of ionizing cosmic rays at various latitudes when slowed down after traversing 15 cm of lead. The following values for the latitude ration I/I_0 (between the number of mesons stopped per unit time in the absorber which disintegrate into electrons detected by the counter at a given latitude and the number stopped and disintegrating near the equator) were obtained: 1.00, 1.14, 1.55, 1.65, 1.57 and 1.91 at north latitudes of 9°, 28.5°, 35.5°, 40°, 42°, and 59°, respectively. Evidence is presented which supports the view that the X-component consists essentially of protons.

1564 The origin of penetrating particles in atmospheric showers. G. Salvini and G. Tagliaferri. *Nuovo Cimento 6*, 108-124(1949) Mar. 12. (in Italian).

The properties of the penetrating component of atmosperic showers were studied at 2,100 m altitude with an apparatus comprising neon lamps that permitted a photographic registration of coincidences. It was found that some of the penetrating particles present in atmospheric showers are produced locally. Although it was not possible to determine the relationship between their number and that of the particles pre-existing in the shower, it was observed that the percentage of locally generated particles is most important in low-density showers. By a simultaneous use of various absorbing substances, (iron and lead), results were obtained that point to the accumulation

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of nucleons and mesons in the penetrating component of the atmospheric showers. The processes taking place in the absorbing substances are similar to those which produce local showers, penetrating or mixed, in the Wilson chamber.

1565 Penetrating Showers. W. B. Fretter. *Phys. Rev. 76*, 511-17(1949) Aug. 15.
A similar paper by the author has appeared in *Am. J. Phys. 17*, 148-53(1949) Mar. It has been listed in *Nuclear Science Abstracts* as Abstract 2-1909.

1566 The penetration of cascade showers and photons. Jean Daudin. *Compt. rend. 228*, 1286-8(1949) Apr. 11 (in French).
Tabulated anticoincidence data taken under lead shields of various thicknesses are given which are interpreted as an indication that the previously discussed results are correct (Auger, et al, *Compt. rend. 228*, 178(1949)) and as discrediting the argument in favor of a light meson (Auger et al., *Compt. rend. 226*, 179(1948)). The results suggest a modified hypothesis, i.e., that the short-lived particles play a role in the origin of nuclear showers rather than in the penetrating capacity which is taken care of by the π and μ mesons.

1567 On pulses produced in ionization chambers by cosmic rays. G. M. Avak'yants. *Zhur. Tekhi. Fiz. 19*, 596-605(1949) May (in Russian).
A theory is given of the method, worked out by Rossi and collaborators (Bridge, *Phys. Rev. 72*, 172(1947)) and permitting the measurement, with the aid of an ionization chamber, not only of the maximal or average value of the ptotential, but also of the whole course of its changes with time, giving thus information as to the shape of the pulse. Since this shape depends on the character of the ionization processes taking place in the chamber, it can furnish valuable data on the nature of the cosmic radiation producing a given pulse. The work of a simple circuit is theoretically discussed, and formulas are given for the evaluation of current and potential pulses.

1568 The specific ionization of the cosmic radiation above the atmosphere. S. F. Singer. *Phys. Rev. 76*, 701-2(1949) Sept. 1 (Letter to the editor).
A direct measurement of the average primary specific ionization of the cosmic rays above the atmosphere has been made in order to gain more information about the nature of the primary radiation. Preliminary results obtained during one rocket flight are presented; they were obtained using a counter telescope (containing a low efficiency counter) in a V-2 rocket. The high altitude (above 55 km) efficiency of the counter has been estimated as 0.670 ± 0.027 (as compared with an efficiency of 0.585 ± 0.019 at the low altitude of the laboratory (120 m). The principal conclusion from the results is that the ionizing radiation above the atmosphere is predominantly singly charged and has an average primary specific ionization appreciably higher than minimum. If the radiation above the atmosphere consists exclusively of primary rays it is noted that: (1) The data are then in clear disagreement with the hypothesis of a pure electronic primary radiation. (2) The data are not consistent with the assumption of a pure proton beam of primaries. If it is assumed that a mixture of particles exists in the primary radiation, then: (1) For an assumed proton-electron mixture the data require the electron intensity to be 41 + 6% of the primary beam. (2) For an assumed proton-α-particle mixture the data give an α-particle intensity of 20 ± 8%. Since there is evidence that secondary radiation from the earth's upper atmosphere contributes significantly to the intensity observed above the atmosphere, it is more realistic to attribute the measured average specific ionization to a mixture of primary and secondary particles.

1569 A study of slow mesons by the method of lagging coincidences. G. B. Zhdanov and A. A. Naumov. *Zhur. Eksptl. i Teoret. Fiz. 19*, 273-82(1949) Apr. (in Russian).
A circuit is described in which mesons are recorded by the method of lagging coincidences analogous to that used by Rossi, et al. (*Phys. Rev. 72*, 120(1947)). Results are given of measurements made in the Pamir mountains, such as the total numbers of slow mesons at altitudes 900 to 5,000 m, the number of mesons generated at 3,860 m, (about 40% of slow mesons are generated in the immediate neighborhood of the apparatus), and the general character of the spectrum in the energy range 0 to 160 Mev.

1570 A high current ion source. Richard B. Setlow. *Rev. Sci. Instruments 20*, 558-60(1949) Aug.
An ion source is described which utilizes a hot cathode as an electron source and an axial magnetic field for focusing. The electron beam is pulsed for 250 μsec, 60 times a sec. Peak ion

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currents of 100 ma are readily obtainable. At a hydrogen pressure of 25 μ of mercury the proton content of the beam is between 30 and 40%. Constructional details and operating conditions are given.

1571 Improvements in or relating to thermionic valve circuits. Edmund Harry Cooke-Yarborough and Charles David Florida. Ministry of Supply Great Britain. Apr. 22, 1949. 6p. (NP-1028).

An invention relating to thermionic valve (electron tube) circuits for the amplification of pulses and other signals of a range of frequencies down to zero frequency is disclosed. Modifications of the above circuits have been proposed including enlarging the condenser shunting the coupling resistance so that the second stage stray capacity becomes small in comparison, and shunting part of the anode load resistance with a condenser to make a network of time constant equal to that of the capacity loaded coupling resistance. According to the invention a direct coupled amplifier comprises a resistance potential divider connected to be subject to the signal voltage developed in the load resistance of a first valve and to apply a fraction of that voltage to the control grid of a second valve, and a condenser connected between an intermediate point in the load resistance and said grid to apply an equal fraction, the load resistance being capacity loaded so that the time constants of its parts on either side of its intermediate point are substantially equal. Two embodiments of the invention are described, by way of example, with reference to an accompanying drawing wherein one is an anode coupled circuit and the other is a cathode coupled circuit.

1572 A new ion source for mass spectrometry. G. P. Barnard. *Nature 164*, 283-5(1949) Aug. 13.

A new model of the type of ion source which utilizes an electron gun to bombard the entering gas stream is described. The details of the usual designs and the aims in source design are reviewed briefly preliminary to a discussion of the new model which requires a much reduced magnetic field and which employs one loop of a prolate trochoid for the electron path. The source described is intended for use with the sector-field type instrument. The increased path-length of the electrons in the gas beam results in more intense ionization and a gain in sensitivity. In addition the necessity for pre-focusing half-plates has been eliminated and a further gain in sensitivity results from the fact that more than 99% of the emission from the filament is effective for ionization. With the geometry used, however, an increase of the energy-spread of the ions and increase of the magnetic field (up to 150 gauss) in the source region also occurs. Further work is necessary on a more complicated source of this type to overcome these defects.

1573 Report on British ion sources. Albert M. Stone. Office of Naval Research London Branch Report OANAR-48-47. Dec. 10, 1947. 17p. (NP-707).

Two developments in ion sources currently underway in Great Britain are described. Typical of the first is the source developed at the Clarendon Laboratory, Oxford University. The other research was performed at the Imperial College of Science and Technology, London University. The former ion source utilizes an electrodeless r-f discharge in H and furnishes about 0.5 ma of ions, of which about 50% are protons. The latter utilizes a 2-cathode discharge tube and furnishes about the same number of ions, but of which about 30% are protons. Both sources require an external axial magnetic field for their operation. In the Oxford tube particular attention is paid to the shape of the plasma near the exit hole in order to obtain as much "natural" focussing as possible. The Imperial College tube is dependent upon the magnetic field in an essential way inasmuch as efficient production of protons depends on the increased mean free path arising from the external magnetic field. Both ion sources emphasize the necessity for a minimum exposed metal surface within the discharge tube.

1574 The use of multigrid tubes as electrometers. J. R. Prescott. *Rev. Sci. Instruments 20*, 553-7(1949) Aug.

The use of several types of multigrid tubes as electrometers has been investigated. They are shown to possess a number of advantages. Details are given for the 6BE6 and 7A8. Grid currents of between 10^{-13} and 10^{-14} amp are obtainable with mutual conductances of the order of 5 μamp/v and an amplification factor of 300.

1575 Effective cross sections of fission of mercury and thallium. T. Franzini. *Nuovo Cimento 6*, 159-60(1949) Mar. 12. (in Italian. Letter to the editor).

Photographic emulsions were immersed in solutions of thallium nitrate or mercury cyanide, then irradiated by fast neutrons. From both the number of nuclei of these elements in the emulsion and the number of neutrons that had traversed it, the probable numbers of tracks corresponding to various

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values of the effective cross sections could be calculated. Since no tracks of fission products were observed in the developed emulsions, it was concluded that the effective cross sections of mercury and thallium for fission, under conditions described, are, respectively, less than 8×10^{-32} cm^2 and less than 1×10^{-31} cm^2.

1576 Energy distribution of thermal neutrons. Heinz Koppe. *Z. Physik 125*, 59-97(1948) Oct. (in German).

The energy distribution of decelerated neutrons is investigated both for the scattering by free protons having a Maxwell velocity distribution, and for the scattering in a paraffin lattice at T = 0°. In the case of free protons, it was found that the velocity distribution, up to energies of about 2 kT, follows practically the Maxwell pattern, then, for high velocities, it changes into Fermi's $1/v^2$ law. In the case of scattering in paraffin, the apparent effective cross section of the protons showed a strong dependence on the neutron velocities, which, at low energies, is determined by the lattice arrangement of the protons, while at higher energies the chemical bonds between the protons and the C atoms also become effective. As a consequence, no thermal equilibrium can be established, at low temperatures, between the neutrons and the lattice; the former can be cooled only to about 100°K.

1577 A measurement of the 200 Kev D-D generator spectrum and output. E. W. Titterton. Atomic Energy Research Establishment Report AERE G/M 35. nd. 3p.

Ilford C_2 plates 100μ thick were used end-on to a heavy ice target. A five-hour irradiation was sufficientlyto give a track density suitable for measurement. Examination of 0° and 90° plates under the microscope showed that the longest proton recoils (corresponding to maximum neutron energy) lay parallel to the plate edges and these were used for the measurement. Tracks deviating more than ±5° from the forward direction were excluded. Two hundred tracks were measured on each plate. In the case of the flux determination it was only necessary to count all proton recoils greater than 6μ long irrespective of orientation in the emulsion. Histograms give the distributions at 0° and 90°. The 90° spectrum shows a line at 2.52 ± .02 Mev of half width 120 Kev and a low energy tail which is presumed to be due to inelastically scattered neutrons from the target assembly. At 0° the spectrum obtained shows a maximum at 3.03 Mev and agrees with theory having regard to the resolution obtained in the monochromatic 90° case. Determination of the flux at the neutron counter was based on a count of 2,000 tracks and gave a figure $(2.4 \pm 0.2) \times 10^3$ neutrons/cm^2/sec. The intensity of the neutrons (number per unit solid angle) at an angle to the deuteron beam in the center of gravity system can be represented by an equation: $I_\phi = (1 + A \cos^2 \phi) \times$ constant.

Taking A = 0.7 the constant can be evaluated from the measurement at 90° and hence an integration may be performed to give the total neutron output of the target. Such an integration leads to the figure $(2.1 \pm 0.2) \times 10^7$ neutrons per second for the output.

1578 Neutron-capture cross section of 85-minute Ba^{139}. L. Yaffe, B. W. Sargent, M. Kirsch, S. Standil, and Jean M. Grunlund. *Phys. Rev. 76*, 617-20(1949) Sept. 1.

Four samples of barium carbonate were irradiated with neutrons at three different times and at three different positions in the heavy water pile. A few days after an irradiation, lanthanum separations were made until no further La^{140} activity could be detected and the lanthanum was discarded. At intervals of four to nine days the La^{140}, grown from the Ba^{140}, was separated and its number of atoms determined with a calibrated Geiger-Müller counter. The fluxes of thermal neutrons were obtained by experiment as far as possible; the maximum used was 2.0×10^{13} neutrons/cm^2/sec. The capture cross section of Ba^{139} was determined as 4.7 ± 1.2 barns.

1579 On the theory of neutron deceleration. W. Bothe. *Z. Physik 125*, 210-24(1948) Oct. (in German).

Both exact and asymptotic formulas are derived for the elastic deceleration of neutrons in a homogeneous medium. The formulas give the energy distribution of neutrons after n collisions, the total energy distribution, and the deceleration range for a given end energy.

1580 Theory of the angular distribution of photo-neutrons from Be^9. C. J. Mullin and E. Guth. *Phys. Rev. 76*, 682(1949) Sept. 1 (Letter to the editor).

A simple theory (*Phys. Rev. 74*, 833(1948); *76*, 234(1949)) of the photo-disintegration of Be^9 has been used to interpret the data recently obtained on the angular distribution of photo-neutrons

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from Be^9. The prospective (loosely bound) photo-neutron is assumed to move in the "effective field" (non-tensor) of the remainder of the nucleus (Be^8). The disintegration process of low energies results from electric dipole transitions from the ground $^2P_{3/2}$ state to S and D states of positive energy. These transitions lead to an angular distribution $d\sigma/d\Omega = a + b \sin^2\theta$, for the ejected neutrons; a and b are functions of the γ-ray energy and may be expressed in terms of the cross sections for the P $\rightarrow$S and P$\rightarrow$ D transitions. Values of a/b have been obtained for the following three cases: (1) The ground state is a $^2P_{3/2}$ state. The $^2D_{5/2}$ - $^2D_{3/2}$ splitting of the unbound D doublets may be neglected. Then $a/b = (17/12) + (25/12)(\sigma_{ps}/\sigma_{pd})$. (2) The $D_{5/2}$-$D_{3/2}$ splitting may not be neglected. Using $P_{3/2} \rightarrow S_{1/2}$ and $P_{3/2} \rightarrow D_{5/2}$ transitions only, $a/b = 1 + (5/3)(\sigma_{ps}/\sigma PD_{5/2})$, where $\sigma PD_{5/2}$ is the cross section for the $P_{3/2} \rightarrow D_{5/2}$ transition. (3) The $P_{3/2}$-$P_{1/2}$ splitting of the bound P levels and the $D_{5/2}$-$D_{3/2}$ splitting of the unbound D levels may be neglected. Then

$$a/b = \frac{2}{3}\left[\, 1 + (2\sigma_{ps}/\sigma_{pd}) \,\right].$$

When these distributions are considered in the light of empirical cross section values, it is concluded that for energies somewhat less than 2.5 Mev, $\sigma_{ps} >> \sigma_{pd}$, and the angular distribution should be spherically symmetrical. For γ-ray energies > 2.5 Mev, the angular distribution should deviate markedly from spherical symmetry. The experimental values of a/b are compared with the calculated values; they are consistent with the last of the three equations (i.e., case (3)) given above.

1581 Evidence on nuclear moments of stable Ge and Si isotopes from microwave spectra. C. H. Townes, J. M. Mays, and B.P. Dailey. *Phys. Rev.* 76, 700(1949) Sept. 1 (Letter to the editor).

The transition J = 0$\rightarrow$1 transition at 3.6 cm wavelength was studied in order to obtain the Ge^{73} spin and quadrupole coupling. The former was determined as 9/2 and the latter as $Q = 0.007^{-24}$ cm^2. It is noted that the spin of Ge^{73}, which has 41 neutrons and an even number of protons, is the same as the spin of Cb^{93} which has 41 protons and an even number of neutrons and Ge^{73} is the lightest nucleus with a known spin as large as 9/2. These facts fit very well into the nuclear shell scheme proposed by Mayer (*Phys. Rev.* 75, 1969(1949)), where the first neutron or proton which goes into the 5g9/2 shell is the 41st. However, the Ge^{73} spin will also fit other nuclear shell schemes. In the case of Si the results obtained indicated zero spin for Si^{28} and Si^{30} (as for the even Ge isotopes) and a spin of 1/2 for the isotope Si^{29}.

1582 Nuclear spin and quadrupole moment of Cl^{36}. C. H. Townes and L. C. Aamodt. *Phys. Rev.* 76, 691-2(1949) Sept. 1 (Letter to the editor).

Examination of the hyperfine structure of the J = 1 $\rightarrow$2 rotational transition of the molecule $Cl^{36}C^{12}N^{14}$ allowed the determination of the Cl^{36} nuclear spin as 2 and its nuclear quadrupole moment as $-0.0172 \pm 0.0004 \times 10^{-24}$ cm^2. The $Cl^{36}CN$ was prepared from a dilute solution of 70 mg of HCl in which the isotopic abundance of Cl^{36} was approximately 0.8%. The microwave spectrometer used was a Stark modulation instrument with a phase detecting amplifier and Esterline Angus recorder (W. Low and C. H. Townes, *Phys. Rev.* 529(1949)).

1583 Rotation levels of the Na^{24} and Ca^{41} nuclei. H. A. Wilson. *Phys. Rev.* 76, 687-8 (1949) Sept. 1 (Letter to the editor).

Tabulated data are given which indicate that the neutron resonance levels of sodium and calcium reported by Adair, et al. (*Phys. Rev.* 75, 1124(1948)) can be explained as rotation levels of the compound nuclei. The calculated values for the radius of a nucleus of given mass number obtained using the author's spherical shell theory (*Modern Physics*, 3rd ed. (1948), p. 273) are in good agreement with the use of $150 + c(j(j+1) - 3/4)$ with c = 8 for calcium and with c = 21 as used in $666+21j(j+1)$ for the levels of sodium. Values of the constant "c" for the isotopes Si^{28}, Al^{28}, Fe^{57}, and Ni^{59} are also tabulated with the corresponding values of the nuclear radius obtained from c; the latter are compared with those obtained from the spherical shell theory and are shown to be in good agreement.

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1584 Instrumentation for a nuclear reactor. D. Cochran and C. A. Hansen, Jr. *Nucleonics 5*, 4-11(1949) Aug.

The problems from the standpoint of instrumentation which are created by the operating conditions of atomic power plants are described. The types of instruments are classified by function as: (1) operations, (2) maintenance, and (3) health instruments. The general design requirements of these instruments are considered and some of the devices now being developed for specific purposes are described.

1585 Experimental photofission thresholds in $_{92}U^{235}$; $_{92}U^{238}$, $_{92}U^{233}$, $_{94}Pu^{239}$, and $_{90}Th^{232}$. H. W. Koch, J. McElhinney, and E. L. Gasteiger. AECD-2699. Jan. 30, 1947. Decl. Aug. 29, 1949. 39p.

An investigation of the photofission thresholds in U^{235}, U^{238}, Pu^{239}, and Th^{232} with a 20-Mev betatron is reported. A method of α self-cancellation is described which permits the detection of fissions and the determination of threshold energies in the two highly α active samples of U^{233} and Pu^{239}. An investigation of the photoneutron threshold in N and the energy calculation from mass data provided a check of the absolute energy scale obtained from voltage measurements on the betatron. From this investigation the photofission threshold values for U^{238}, U^{235}, Pu^{239}, and U^{233} show a maximum difference or spread of 0.23 Mev, whereas the theory predicts a spread of 1.7 Mev. Also, the order of the experimental thresholds are not the same as the predicted order. Emphasis was placed on determining this order as accurately as was possible. For this reason all the isotopes were referred to the U^{238} threshold and were investigated in succession with U^{238}. The thresholds of U^{235}, U^{238}, and Th^{232} were determined most accurately. According to theory the U^{238} threshold should be larger than the U^{235} threshold by approximately 0.6 Mev. The experiment showed definitely that the order is reversed with the U^{235} threshold the larger one by 0.23 ($\pm$0.10) Mev. The orders of the experimental thresholds for U^{239} and U^{233} are also not in agreement with theory.

1586 Angular distribution of α-particles from the $Li^7(p,\alpha)He^4$ reaction. L. H. Martin, J. C. Bower, D. N. F. Dunbar, and F. Hirst. *Nature 164*, 310(1949) Aug. 20 (Letter to the editor).

The distribution of the α particles from the reaction $Li^7(p,\alpha)He^4$ has been investigated for proton energies in the range 130-960 kev using nuclear emulsion plates in a camera which permits observation of α particles in the angular ranges 13-90° and 167-90° to the incident proton beam on each plate exposed. Curves of the variation with proton energy, E, in the coefficients A(E) and B(E) of Heydenburg's expression (*Phys. Rev. 73*, 241(1948); *74*. 405 (1948)) for the angular distribution: $Y(\theta) = Y(90^\circ)\ [1 + A(E)\cos^2\theta + B(E)\cos^4\theta]$. are shown. The measurements indicate that B(E) is very small below 0.5 Mev and then approaches a value of approximately -0.5 at 1 Mev.

1587 A fast recycling cloud chamber and pulsed magnetic field equipment for use with pulsed accelerators. E. R. Gaerttner and M. L. Yeater. *Rev. Sci. Instruments 20*, 588-95(1949) Aug.

A cloud-chamber apparatus has been developed for use with new high energy pulsed accelerators, such as the present 100-Mev betatron and the 300-Mev synchrotron now being constructed by the General Electric Company. The cloud chamber is operated at a repetition period of about 5 sec. An "overcompression" step in the cloud-chamber cycle causes old tracks to be evaporated by momentary heating of the gas through compression. A pulsed magnetic field of 12-msec duration is used with this cloud chamber. The field is produced by discharging capacitors through Helmholtz coils. With these short current pulses, strong fields (20,000 gauss or more) are obtainable at fast cloud-chamber recycling rates with relatively small heating of the coils.

1588 New accelerators of charged particles. A review of published data. II. A. P. Grinberg. *Zhur. Tekhi. Fiz. 19*, 153-83(1949) Feb. (In Russian. See also NSA 3-410).

In this second part of a review of works on accelerators, theoretical and structural data are given concerning the "phasotron." Veksler gave this name to the machine known in American literature as the synchrocyclotron or the modulated-frequency cyclotron. Veksler (*Doklady Akad. Nauk S.S.S.R. 43*, 346(1944) and *44*, 393(1944)) was the first, it is claimed, to discover the auto-phasing principle and the possibility of a cyclotron based on it. All the 27 references are American.

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1589 Note on removing the deuteron-induced color from quartz target plates. A. A. Schulke and R. E. Nuelle. *Rev. Sci. Instruments 20*, 623-4(1949) Aug. (Laboratory and shop note).

A method is described for restoring quartz plates, which had been used as a visual aid in the alignment of the various cyclotron assemblies, to their original transparent state. Heating experiments were conducted and it was found that at 280°F a fluorescence was observed accompanied by an increase in transparency; at 600-700°F the plates were left perfectly clear.

1590 Calibration of electron-sensitive emulsions. Barbara Zajac and Marion A. S. Ross. *Nature 164*, 311-12(1949) Aug. 20 (Letter to the editor).

The calibration of Kodak Nt4 photographic emulsions for β particles has been extended to an upper energy limit of 250 kev. The method used for calibration has been reported in an earlier letter (*Nature 162*, 923(1948)). New observations have been made at β-ray energies of 40, 60, 100, 147, 200, and 250 kev in emulsion coatings of 200 μ thickness. Mean values for the total range of the β-particle tracks and for the number of grains per track at a series of energy values are given in tabular form; these include all the systematic observations which have been made to date. Calculated ranges are also given for comparison. In addition the mean number of branches per 100 μ of track has been determined from a larger group of 143 tracks having a total of 43 branches. The range-energy relation given by Herz (*Phys. Rev. 75*, 478(1949)) is in good agreement with the observed values except at the highest energies (200 kev and above).

1591 Characteristics of halogen counters. Sidney H. Liebson. *Rev. Sci. Instruments 20*, 483-4(1949) July.

Some characteristics of halogen counters have been obtained which enable their preparation for given operating voltages. Other factors influencing their behavior are discussed with a view toward obtaining optimum results.

1592 Counting with Geiger Counters. Homer E. Newell, Jr., and Eleanor C. Pressly. *Rev. Sci. Instruments 20*, 568-72(1949) Aug. (See also NSA 1-460).

The coincidence rate of a perfectly efficient two-counter telescope is obtained in terms of the radiation intensity and the effective dimensions and separation of the counters comprising the telescope. Formulas are presented for the counting rate in a field of isotropic radiation and in a field where radiation varies with the zenith angle in accordance with a cosine squared law. By means of the formulas the counting rate may be located between an upper and a lower bound which in most practical cases differ by only a few per cent. The information embodied in the formulas is also presented graphically in a form convenient for ready calculation of the ratio of coincidence rate to radiation intensity once the effective dimensions and separation of the counters are known.

1593 Detection of x-ray quanta by a cadmium sulphide crystal counter. Samuel G. Zizzo and Joseph B. Platt. *Phys. Rev. 76*, 704-5(1949) Sept. 1 (Letter to the editor).

Voltage pulses of the order of 50 μ volts have been obtained from a CdS crystal irradiated with 0.5A x-rays. The circuit used is shown in a schematic diagram and curves are given of the aluminum absorption of the radiation used and of the maximum amplitude of the pulses obtained as a function of the field strength in the crystal. Assuming the largest pulses (68 μvolts) to be due to 45 kev quanta, a value of 14 ev is obtained for the energy necessary to produce one conduction electron.

1594 Experiments on the stopping power and resolving power of nuclear research emulsions. E. W. Titterton and T. A. Brinkley. Atomic Energy Research Establishment Report AERE G/R 326. July 1949. 10p.

The stopping power and resolving power of the Ilford type emulsions D_1, E_1, C_2, B_2, and G_5, in order of increasing sensitivity, and the Kodak types NT2a and NT4 for the 2.1-Mev α particle of samarium have been determined. Experiments with uranium-loaded emulsions also show that the stopping power of a wet emulsion is 10% smaller than that of a dry emulsion and that the resolution is also impaired.

1595 A new method of energy determination of γ-quanta emitted by weak sources. M. Ceccarelli, M. Merlin, and A. Rostagni. *Nuovo Cimento 6*, 151-7(1949) Mar. 12 (in Italian).

The circular magnetic spectrograph introduced by Occhialini for the investigation of β spectra of very low intensity, (described by Bocciarelli, *Nature 128*, 374(1931)), can be applied to γ spectra. Preliminary experiments on K^{40} and RaB + C are described, in which the secondary sources were Pb (photoelectric effect) and Al (Compton effect). The method is expected to be useful in any work with radioactive sources of low intensities and large surfaces. An account is also given of some preliminary experiments on the β emission of K^{40}.

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1596 On the form of the electrical pulses supplied by ionization chambers. Pierre Billaud. *Compt. rend. 228*, 1212-14(1949) Apr. 4 (in French).

Calculations are made to obtain an expression for the average amplitude of the pulse which results in an ionization chamber traversed by a charged particle. Some of the interesting experimental applications of the aforementioned expression are discussed. If the horizontal sweep of the oscillograph is regulated in such a fashion that the period is of the same order of magnitude as the lifetime of the positive ions, and of a constant time θ less than τ(the interval until the last ion disappears), but very large compared to the lifetime of the electrons, the pulse is viewed instantaneously as detached and is a measure of the work on the electrons. In addition the work done on the ions of both signs may be determined from the total area bounded by the pulse. The ionization-range relationship for the particle studied is also known. Finally, it is possible to see that for a given shape of electrodes (plane or spherical) the ratio of the work of the ions of either sign to the total work is a function determined by the range and by the orientation with respect to the field and may be obtained from theory or experiment.

1597 Pinhole camera for gamma-ray sources. D. Eugene Copeland and Emanuel W. Benjamin. *Nucleonics 5*, 45-9(1949) Aug.

A pinhole camera which utilizes selective interference from γ-ray sources is described. The camera views a ¾-in. field at a distance of 5 in. from the pinhole. The images obtained indicate the camera's usefulness as a tool where exposure length is not of critical importance and for checking on material that cannot be handled, e.g., a contact or radioautograph.

1598 The scintillation counter. I. The existence of plateaus. Lawrence B. Robinson and James R. Arnold. *Rev. Sci. Instruments 20*, 549-53(1949) Aug.

A method has been developed whereby inorganic phosphors can be mounted on a photomultiplier tube in thin films. The ZnS:Ag phosphor is quite satisfactory for use in conjunction with the 931A photo-tube. Plateaus have been established similar to those associated with Geiger-Müller counter tubes and the associated circuits.

1599 Double scattering of protons in helium. D. C. Dodder. *Phys. Rev. 76*, 683(1949) Sept. 1 (Letter to the editor).

In order to determine the feasibility of performing the experiment of the double scattering with protons recently suggested by Wolfenstein (*Phys. Rev. 75*, 1664(1949)), the angular distribution of yield from the second scattering at 90° in the center of mass system has been calculated as a function of energy for each of the possible doublets. An expression for the final intensity is obtained which is the average of the intensities of the waves corresponding to the two initial spin directions. The product of the differential cross section of the two scatterings in the laboratory system may be written $M + N \cos\phi$. Tabulated values are given for M and N measured in square barns, as functions of E, the laboratory energy in Mev of the initial protons in the laboratory system. The results indicate that, as expected, a measurement of the asymmetry as a function of energy would conclusively decide which doublet exists. Evidence is presented which indicates the likelihood that a single measurement at E = 2.8 Mev would be decisive. Thus, it is concluded that measurement of the polarization effect by means of the double scattering might be quite possible.

1600 On the penetrating power of electrons of 17 Mev. M. Ageno and M. Chiozzotto. *Nuovo cimento 6*, 81-93(1949) Mar. 12 (in Italian).

Using a triple-coincidence apparatus with a high resolving power, a series of absorption curves were obtained, under conditions of good geometry, for electrons with energies up to 17 Mev. The electrons used were secondary electrons produced in aluminum by γ rays of 17.6 Mev, which were obtained from the reaction $Li^7(p,\gamma)$. The absorbing substances were aluminum, iron, cadmium, lead, and paraffin. The curves show long "tails," of an intensity not exceeding 2% of the incident electronic radiation, which are partly due to secondaries of this radiation. The penetrating powers, calculated in terms of reductions to ½, to 5%, and to 1%, show a regular decrease with increasing atomic numbers.

1601 The penetration of high energy electrons in aluminum. F. L. Hereford and C. P. Swann. *Phys. Rev. 76*, 570-1(1949) Aug. 15 (Letter to the editor).

In order to check the calculations of Fowler, et al. (*Revs. Modern Phys. 20*, 237(1948)), measurements of the absorption in aluminum of monoenergetic electrons in the range from 3 to

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12 Mev have been made. For this purpose the B^{12} β spectrum (produced through the $B^{11}(d,p)B^{12}$ reaction) analyzed by the 90-degree magnet normally used for the Van de Graaff beam (resolution ~ 4%) was used. Using a triple coincidence train of Geiger-Müller counters, absorption curves were obtained for the analyzed beam in aluminum. A Kurie plot of the data yielded an end-point at total energy 27.3 m_0c^2 (13.4 Mev). The curves of the maximum range as a function of electron energy are compared with the experimental curve obtained by Alvarez (*Phys. Rev.* 75, 574(1948)) and with the calculated values of Fowler, et al. The agreement obtained is good, although it is noted that in the high energy region the experimental points indicate a practical range somewhat less than that expected on the basis of the theoretical energy loss. It is suggested that this may be due to multiple scattering and thin-foil effects on the energy-loss of electrons in this range (M. M. Slawsky and H. R. Crane, *Phys. Rev.* 59, 1203(1939)).

1602 Phase shifts in proton-alpha-scattering. C. L. Critchfield and D. C. Dodder. *Phys. Rev.* 76, 602-5(1949) Sept. 1.

Phase-shifts in S and P waves are found that fit the observed scattering of protons by He^4 within the experimental accuracy of recent results (Freier, et al., *Phys. Rev.* 75, 1345(1949)). The S wave phase is negative and rather small. The $P_{1/2}$ and $P_{3/2}$ waves have different phase-shifts, both positive, but there are two sets of possible values, one corresponding to a normal doublet in Li^5 and the other to an inverted doublet. In both cases there is resonant scattering and strong polarization of the proton beam. Measurement of the polarization would decide between the doublets. The values of the phase-shifts presented are those which minimize the sum of squares of per cent differences between observed and calculated differential cross sections.

1603 The disintegrations of Sn^{121} and Sn^{123}. R. B. Duffield and L. M. Langer. AECD-2697, nd. Decl. Aug. 30, 1949. 7p.

The 39.5-min activity of Sn^{123} and the 28-hr activity Sn^{121} have been studied by means of a magnetic lens spectrometer. Sources were prepared by irradiating metal foils of separated isotopes in the thermal column of a nuclear reactor. The separated isotopes contained 70.7% Sn^{121} and 95.4% Sn^{120}, respectively. A momentum distribution of the electrons emitted by the 39.5-min period of Sn^{123} is plotted. In addition to the β spectrum, there is the line of internal conversion electrons corresponding to a γ-ray energy of 0.53 ± .005 Mev. The decay period of this line was followed and found to be 39.5 min. In a separate experiment, coincidences were observed between the internal conversion electrons and the β particles. The γ ray apparently follows the β decay and corresponds to an undelayed transition to the ground state of Sb^{123}. From the relative areas under the momentum distribution curve, a value of 0.12 was obtained for the ratio of internal conversion electrons to β disintegrations. From the coincidence measurements the ratio was found to be 0.11. A Fermi plot of the β spectrum of Sn^{123} is given. The momentum distribution of the β rays of Sn^{121} is plotted. A Fermi plot of the data obtained with two different resolutions of the spectrometer is drawn.

1604 Decay of gross fission product β activity and energy after short bombardments. N. Elliott and N. Sugarman. AECD-2698, nd. Decl. May 17, 1949. 10p.

The decay of the β radiation emitted from unseparated fission products following irradiations of 10 sec, 1 min, and 5 min has been determined. A Lauritsen electroscope was used as the detecting instrument, and because of difficulties in calibration it was impossible to make a correlation in the irradiated sample between divisions per second observed with the electroscope and disintegrations per second. After a 10-sec irradiation the initial half-life was 5 sec; after 10 min of decay the half-life was 3 min.

1605 Neutron deficient radioactive isotopes of rhenium. G. Wilkinson and H. G. Hicks. AECU-409 (UCRL-393), July 15, 1949. 36p.

A study has been made of neutron deficient radioactive isotopes of Re. Using the 60-in. Crocker Laboratory cyclotron, bombardments have been made of Ta with 38, 30, and 19 Mev α particles, of W with 10 Mev protons, and of Re with fast neutrons. Four new radioactive isotopes

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were observed; the characteristics of these and of the previously known 40-day Re^{184} which has been restudied are given below.

Isotope	Type of Radiation	Half-Life	Energy of radiation in Mev Particles	γ-rays	Produced by
Re^{182}	K or I.T. e^-,γ	64.0±0.5 hr	0.11,0.27(abs) 0.040,0.98 0.059,0.117 0.152,0.210 0.180,0.238 0.276,0.334 (spec)	L,K x-rays 0.22,1.5(abs) 0.110,0.129, 0.250(Spec conv) 0.222,0.346 (spec and spec conv)	Ta-α-3n W-p-n
Re^{182}	K or I.T. e^-,γ	12.7±0.2 hr	0.16,~1(abs) 0.040,0.098 0.59,0.117 0.152,0.210 0.180,0.238 0.276,0.334 (spec)	L,K x-rays 0.4,1.6(abs) 0.110,0.129, 0.250(spec conv); 0.222,0.346 (spec and spec conv)	Ta-α-3n W-p-n
Re^{183}	K,e^-,γ	~120 days	0.16(abs) 0.069,0.078 0.182,0.240 (spec)	L,K x-rays 1.0 (abs); 0.081,0.252 (spec conv)	Ta-α-2n W-p-n
Re^{184}	K,e^-,γ	4.0 days	0.2,0.7(abs) 0.031,0.040, 0.089,0.147, 0.135,0.193, 0.215,0.273, (spec)	L,K x-rays 0.043 0.205,0.285 (spec conv); 0.159(spec and spec conv)	Ta-α-n W-p-n Re-n-2n
Re^{184}	K or I.T., e^-,γ	2.2 days	0.2,1.1(abs) 0.052, 0.031,0.040, 0.089,0.147 (spec)	L,K x-rays 0.043(spec conv) 0.159(spec and spec conv)	Ta-α-n W-p-n

1606 Basic concepts of radioactivity. William H. Sullivan. Naval Radiological Defense Laboratory Report AD-56(L). Jan. 1, 1949. 11p.

This talk was presented by invitation at the Conference on Nuclear Chemistry sponsored by the Chemical Institute of Canada. The meetings, which sought to give Canadian scientists a general introduction to the field of nuclear chemistry, were held at McMaster University, Hamilton, Ontario, on May 15, 16, and 17, 1947. Decay processes, nuclear reactions involved in the production of radioactivity, and the interaction of nuclear radiation with matter were discussed.

1607 Beta decay of thulium-170. R. L. Graham and D. H. Tomlin. *Nature 164*, 278-9(1949) Aug. 13 (Letter to the editor).

The β disintegration of Tm^{170} (127 days) has been studied in detail and the results obtained agree with those of Saxon and Richards (*Bull. Am. Phys. Soc. 24*, 35(1949)), but do not agree with those recently reported by Grant and Richmond (*Nature 163*, 840(1949)). A sample of pure thulium oxide (Tm_2O_3), was irradiated in the Harwell pile, and the activity studied by means of a thick-lens β-ray spectrometer, and by coincidence and absorption techniques. A Fermi plot derived from the spectrometer measurements on the continuous β spectrum, and from the exact calculation of the Fermi function without screening correction, is shown. The linearity of the plot indicates the presence of only one β-ray group of maximum energy 970 ± 5 kev. Further

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evidence of the emission of an 83-kev γ ray was obtained. All the results obtained are consistent with the simple decay scheme shown in which Tm^{170} decays to Yb^{170*} and the latter goes to the ground state with the emission of an 83-Kev γ ray. The percentages of K and L conversion are in reasonable agreement with the theoretical results for an electric quadrupole transition.

1608 The excited state of Li^7 and the angular yield in $Li^6(d,p)Li^{7*}(\gamma)Li^7$. S. S. Hanna. *Phys. Rev.* 76, 686-7(1949) Sept. 1 (Letter to the editor. See also NSA 3-895).

It is suggested that a simple determination of the complexity of the angular distribution function of the γs in $Li^6(d,p)Li^{7*}(\gamma)Li^7$ at a deuteron energy between 400 and 900 kev should provide definite information about the spin of the excited state. Previously it had been proposed by Feld (*Phys. Rev.* 75, 1618(1949)) that the measurement of a possible angular correlation in successive α-γ emission in the $B^{10}(n,\alpha)Li^{7*}(\gamma)Li^7$ reaction would provide a means of testing the various assignments which have been proposed for the spin of Li^{7*}. However, it is noted that the most significant result which could be obtained in the B^{10} reaction is that a definite angular correlation of the form $1 + A\cos^2\phi$ in this experiment would exclude the possibility of $I = 1/2$ for the excited state, but allow $I \geq 3/2$.

1609 On the theory of double β decay. Bruno Touschek. *Z. Physik* 125, 108-132(1948) Oct. (in German).

In the light of Fermi's original theory (*Z. Physik* 88, 161(1934)) the double β decay, i.e., an emission of two electrons, or two positrons, in one elementary act, is very improbable. The assumptions of that theory lead mostly to transformations where an emission of two β particles is accompanied by that of two neutrinos. An enlarged analysis of the problem, based on scalar and pseudoscalar assumptions as to the interactions involved, leads to a mixed vector-pseudovector theory of a pure double β decay. It is found that, even when allowing for forbidden transitions, the half-life periods are of the order of 10^{13} years, a value that is just at the limit of possible measurements.

1610 On the theory of internal conversion. H. A. Meyer. *Anais Acad. Brasil. Cienc.* 21, 101-110(1949) June 30. (See also NSA 1-1690).

Calculations have been made with respect to the K-shell internal conversion for a Ra-C atom (Z = 84). The value of the internal conversion coefficient corresponding to Schönberg's theory is obtained for γ rays having energies in the range 0.8 - 2.2 Mev. Tabulated values of three terms, i.e., l_k^+ and l_k^-, the internal conversion coefficients for the retarded and advanced interactions, respectively, and a factor F which takes the interference terms into account are given as a function of the γ-ray energy. The curves for l_k^+ and l_k^{at}, the internal conversion coefficient for the half-retarded, half-advanced interaction, have also been plotted. At the highest energy considered, the two aforementioned coefficient values differ by about 30%. It is noted that within the actual experimental precision the internal conversion coefficients could probably be located on either curve. Computations for the half-retarded, half-advanced quadrupole potentials are now in progress.

1611 On an unusual activity of metals bombarded by deuterons. Catherine Chamié and Hélène Filçakova. *Compt. rend.* 228, 1289-91(1949) Apr. 11 (in French).

In addition to the usual expected activities it was found that gold bombarded with deuterons also exhibited an unexpected short-lived activity. A curve is given showing the variation in this activity with depth in the metal. The intensity of this singular activity in gold decreases rapidly at depths of from 0 to 0.01 mm, remains constant from 0.01 to 0.06 mm, and then decreases again. Similar results were obtained for deuteron bombardment of silver, copper, nickel, and aluminum. It is noted that this activity might possibly be produced by the protons which accompany the deuterons. Further experiments are in progress to explain these phenomena.

1612 The application of Dyson's methods to meson interactions. P. T. Matthews. *Phys. Rev.* 76, 684-5(1949) Sept. 1 (Letter to the editor).

The vector interaction of neutral scalar mesons with nucleons is considered and it is shown that the technique developed by Dyson (*Phys. Rev.* 75, 486(1949)), by combining the electrodynamic theories of Schwinger and Feynman, can be applied even to the more general meson interactions which contain derivatives of the field variables that lead to Hamiltonians in the interaction representation (which depend explicitly upon the direction of the general space-like surfaces). Formulas for the aforementioned case are obtained which permit the application of the graphical methods of Dyson with only trivial changes. An exactly similar analysis is possible for all meson interactions with either nucleons or photons.

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1613 Applications of wave mechanics to the study of the properties of the electron, to valences and to the structure of organic molecules. Jean Guy. *Rev. gen. sci. 56*, Nos. 5-6 103-19(1949) (in French).

The implications of wave mechanical theory to the chemist are considered. The general properties of the electron in the light of modern quantum theory are discussed preliminary to a treatment of some of the chemical applications of the more modern ideas. In particular the modification in the concept of "valence" is noted as well as recent knowledge which has been obtained on the structure of organic molecules.

1614 Electrons ejected by polarized radiation. K. H. Spring. *Proc. Phys. Soc. (London) 62A*, 529-30(1949) Aug. 1. (Letter to the editor).

The azimuthal distribution of recoil electrons ejected by plane polarized radiation is considered and it is found that: $n(\chi)\, d\chi \sim (1 - A \cos^2 \chi)\, d\chi$, in which χ is the component of angle measured in the plane perpendicular to the original photon. At very high energies the electrons are emitted with azimuthal symmetry by polarized radiation. The polar distribution of the electrons is shown for 140-kev radiation.

1615 "Enchainement" and quantization: Schrödinger's equation for a linear harmonic oscillator. Gabriel Viguier. *Rev. sci. 86*, 519-22(1949) July-Aug. (in French).

Considering the special case of Planck's linear harmonic oscillator, the possibilities of analogy between "enchainement" and quantization are demonstrated. It is seen that one is able to approach an oscillatory theory by departing from the curves of isometric parameterization, that is to bring the study of the energy levels again to that of the canonical forms of the equation of Riccati.

1616 Gravitational field of a particle. John L. Synge. *Nature 164*, 148-9(1949) July 23 (Letter to the editor).

The gravitational field of a particle (point-mass) is considered. From various considerations it is concluded that a particle which exerts a gravitational field must travel faster than light. It is suggested that the unusual properties of a gravitating particle warrant further study.

1617 On the classical calculation of the energy and the amount of motion of a purely electromagnetic electron. Louis de Broglie. *Compt. rend. 228*, 1265-8(1949) Apr. 11 (in French).

It is shown that the recent calculation of Kwal *(J. phys. radium 10*, No. 8, 103) does not demonstrate the inexactness of the expression: $d\nu = d\nu_0 \sqrt{1 - \beta^2}$ which relates the actual volume to that measured by an observer relative to whom the electron has a velocity of βc. Rather, the contradictory nature of Kwal's calculations lies in evaluating the energy and quantity of motion of a "purely electromagnetic" electron. The concepts employed are basically in error, then, and have no reality for an unstable electron.

1618 On the damping of the oscillator. Hans Bauer and J. Hans D. Jensen. *Z. Physik 124*, 580-5(1948) Sept. (in German).

Bloch *(Physik. Z. 29*, 58(1928)) has found that Schroedinger's *(Naturwissenschaften 14*, 664(1926)) wave packet of eigenfunctions of an oscillator does not spread apart, even if the oscillator radiates energy into space; the center of gravity of the packet performs the classical motion of a damped oscillator. A new simple proof of this proposition is given here.

1619 On a projective relativity theory with variable gravitational invariants. Guenter Ludwig. *Z. Physik 124*, 450-7(1948)(in German).

A simple general method is given for the derivation of affine magnitudes from projective magnitudes. Using this method, the projective metric field is tied-in with the corresponding affine metric field, and, in particular, a connection is established between the projective and affine curvature tensors. The problem in view is to explain by the structure of the space, not only the gravitational, but also the electromagnetic field. Kaluza *(Sitzber. preuss. Akad. Wiss., Physik, math. Klasse*, 966(1921)) suggested a solution of this problem in a five-dimensional theory. Veblen (Projektive Relativitaetstheorie, Berlin, 1933) interpreted the five dimensions as a projective description of a four-dimensional universe. Pauli (*Ann. Physik 18*, 305(1933)) presented this theory in a symmetrical form, in which it was later applied by Pais *(Physica 8*, 1137(1941); *9*, 267 and 407(1942)) to meson fields. The present author develops a modification in Pauli's theory, made by Jordan and suggested by the latter's cosmological speculations

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(Die Herkunft der Sterne, Stuttgart, 1947) and ideas on the cosmological variability of β decay (Jordan and Mueller, *Z. Naturforsch. 2a*, 1(1947)). An attempt is made to develop a field theory by using a variable gravitational invariant.

1620 The operator for the electromagnetic interaction energy of charged particles. Jean G. Valatin. *Compt. rend. 228*, 1283-4(1949) Apr. 11 (in French).

The expression deduced by Möller by the correspondence method (*Z. Physik 70*, 786(1931)) provides an approximate description of the electromagnetic interaction of particles in relativistic fashion when considered with the expressions for the wave equation of the state Φ_U of a system of charged particles, obeying an exclusion principle, for a canonical transformation: $\Phi_U = e^{(i/\hbar)Wt}\Phi$. In order to obtain an expression for the elements of the matrix for the total electromagnetic interaction in the chosen notation, it is necessary to complete the elements of the matrix for the Coulombian energy with a term dependent only on the transverse currents, so the sum will give the correct relativistic variance. The results obtained are compared with Möller's matrix.

1621 Radiation from a uniformly accelerated charge. D. L. Drukey. *Phys. Rev. 76*, 543-4 (1949) Aug. 15.

Although it has been stated that there is no radiation from a charge moving in the relativistic equivalent of uniform acceleration (M.Born, *Ann. Physik 30*, 39(1909)) when means of measuring the radiation are used which are suitable to the infinite extent of the path, such is not the case. The fields for a uniformly accelerated charge as deduced by conformal transformation from rest are found to correspond to one-half the sum of advanced and retarded potentials for two charges.

1622 Some questions of classical electrodynamics of electron motion. G. Zin. *Nuovo Cimento 6*, 1-23(1949) Jan. 20 (in Italian).

Equations of the motion of electrons, given by Eliezer (*Proc. Cambridge Phil. Soc. 39*, 173(1943), *Revs. Modern Phys. 19*, 147(1947), *Phys. Rev. 71*, 49(1947)) are submitted to a critical analysis. They differ from Dirac's equations by a factor $2k + 1$ multiplying the radiation reaction term. The rectilinear motion of a particle of charge e, projected toward a fixed particle of charge ne, is studied for the four cases $2k + 1 \gtrless 0$, $n \gtrless 0$. It is found that the particles can collide if $n(2k + 1) > 0$, while no collision is possible if $n(2k + 1) < 0$. Furthermore, in the latter case the distance between the two particles reaches a non-zero minimum, from which the moving particle escapes into infinity with a velocity approaching a limit. This limit, which, for $2k + 1 < 0$, $n > 0$ is different from the velocity of light, equals the latter when $2k + 1 > 0$, $n < 0$. Consequently, the use of the factor $2k + 1 > 0$ is here inadmissible, and the Dirac equation with $k = 0$ should be applied to those cases. The problem of the elementary oscillator is discussed, with the result that here the use of a factor $2k + 1 < 0$ leads to unacceptable results.

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